National Aeronautics and Space Administration

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SPACE SCIENCE ADVISORY COMMITTEE

November 15–17, 2004

Marriott Newport Beach
Irvine, California

MEETING REPORT

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Marc S. Allen	**Andrew B. Christensen**
Executive Secretary	**Chair**

SPACE SCIENCE ADVISORY COMMITTEE (SScAC)
November 15–17, 2004
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Irvine, California

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Monday, November 15, 2004

Welcome and Agenda

Dr. Andrew Christensen, chair of the Space Science Advisory Committee (SScAC), welcomed the SScAC members, members of the Earth System Science and Applications Advisory Committee (ESSAAC), and visitors. The members of the ESSAAC participated in the meeting by special invitation of the SScAC and Mr. A. V. Diaz, the Associate Administrator of the Science Mission Directorate (SMD), in preparation for the future merger of the two advisory committees. Dr. Christensen introduced the senior NASA managers present, then asked the members of both committees to introduce themselves and note their science areas. Dr. Larry Smarr, chair of the ESSAAC, welcomed the members. Mr. Diaz thanked the members of both committees for contributing their time and talent to the issues the committees were to address at this meeting.

NASA Science Program Transformation

Mr. Diaz spoke to just a few of the slides in his briefing package; the remainder were included for the members to peruse at their leisure. He began with the NASA vision and mission formulated in 2001, which still apply to the Agency. In January 2004, President Bush articulated the Vision for Space Exploration, with the expectation that NASA would align its programs around the Vision. Mr. Diaz has found nothing in the directorate's science programs that is inconsistent with the President's Vision. However, program priorities will be examined critically to ensure consistency with the Exploration Vision. NASA will be re-evaluating the priorities from the National Research Council (NRC) Decadal Surveys in terms of the transformation of NASA. The report of the President's Commission on Space Exploration (the Aldridge Commission) concluded that NASA is the right organization to implement the Exploration Vision, provided it takes certain actions. The meeting today reflects the reorganization of NASA science activities to align with the Exploration Vision and with the Aldridge Commission's recommendations. Mr. Diaz intends the transformation process in the SMD to be deliberate, methodical, and inclusive.

Mr. Diaz has witnessed two generations of activity at NASA during his tenure of 40 years with the Agency. The first generation, from 1958 to about 1978, was an exploratory phase. The thrust of NASA programs during that time was to try to understand a largely unknown environment. Instruments were simple, with neither microprocessors nor digital memory capability. The Viking and Voyager missions in the latter stages of that generation were the first with a major science component. These missions led into the second generation of NASA science, when the "great observatories" in both astronomy and Earth system science were developed, launched, and successfully operated. Not until the latter part of this second science generation was there much scientific exploration of Mars. Fifteen years ago, the Office of Space Science and Applications had a budget of $1.8 billion. Today, the combined budget for space and Earth science in the SMD is $5.5 billion. Over that period, the science programs have grown at an average compounded annual rate of 8 percent.

Looking forward to a new, third phase of NASA science, Mr. Diaz expects it to reflect a convergence of exploration and science. A new influence on NASA science is the expectation

that the culture of discovery in space science will merge with the culture of prediction central to the Earth science programs. Out of this merger will come a new science focus that will help NASA achieve the Exploration Vision. While leaving details of the planning process to the subsequent briefing by Dr. Marc Allen, Mr. Diaz said he expects involvement of the science community in this process to be sufficient to create a community sense of ownership.

Discussion: Dr. Christensen asked for clarification on how the roadmapping teams that were set up before the transformation fit with the multi-tier Agency roadmapping being done at Headquarters. Mr. Diaz replied that NASA is working to make the legacy roadmapping and planning processes a mechanism for input to the Agency-level strategic roadmaps.

In response to a question on SMD technology development to support future missions, Mr. Diaz said that he wants a concerted, deliberate process to understand SMD's technology needs. Of the two activities in progress to do this, the SMD technology roadmapping is being led by Harley Thronson. That activity will present the technology requirements for Agency-level strategic science objectives. Mr. Diaz is working to ensure that the NASA reorganization does not cause needed technology development to be lost. In response to a question from Dr. Fawwaz Ulaby on ESSAAC's past use of a subcommittee specifically focusing on technology needs, Mr. Diaz suggested that a similar arrangement would be appropriate for the members to discuss. With respect to when technology development activities would appear in the budget requests, he said that, for the near term, SMD will try to cover gaps and immediate needs from existing funding lines. For the longer term, he is more open to considering a diverse set of solutions. There may be some line items for technology development; in other cases, technology development may be embedded in programs. Dr. Asrar agreed with the point that SMD needs technology priorities identified and plans in place to address them. At times in the past, he said, technology development became so generic that other parts of the Agency were not interested. The relevance to Agency missions needs to be maintained. Mr. Diaz said that the Earth Science Technology Office (ESTO) has been very successful in developing technologies that missions have used. In space science, early technology development has been successfully embedded in programs. Multiple elements could have a place in SMD technology development. He would like a full discussion of the competed elements of technology development programs, as well as ways to have technology development programs that cut across discipline areas of the total science program.

Mr. Diaz agreed with a comment from Dr. Kenneth Jezek on the value of looking for lessons of common interest to both Earth and space science in their respective approaches to mission data management. The space science community, Mr. Diaz said, has done well with distributed data management approaches. The Earth science community has done well in sustaining and improving a data archive system that provides a broad community of users, beyond just research scientists, with interactive interfaces for making the data accessible. A single solution probably is not the right answer, but there is much the two communities can learn from each other.

Dr. Daniel Jacob expressed concerns from the Earth science community that resources from Earth observing activities would be redirected to support Moon and Mars exploration. Mr. Diaz replied that there would be increased evidence over the next several months that Earth science has a role in the Exploration Vision, as well as in the broader NASA mission. As an update to the review of Agency-level strategic objectives, Mr. Diaz said that NASA is working on understanding the relationship of all its programs and activities to national goals and objectives in the Exploration Vision and other authoritative documents. That process should be completed in a few more months. The six strategic objectives for which SMD has primary responsibility are being traced back to national objectives. Once that is done, the picture of how all the pieces fit together,

including the Level 0 requirements and the additional strategic objectives, should be clearer. Dr. Asrar added that the legacy roadmapping and planning processes are being brought into the higher-level strategic planning process and will be important for integrating the six science roadmaps for which SMD has lead responsibility. In reply to a question from Dr. Timothy Killeen on whether NASA may be entering a science-integration phase after a phase of scientific exploration, Mr. Diaz said that a new view of how science in NASA should be organized is emerging, but the principles of that new organization are not yet clear. Later in the discussion, Mr. Diaz reiterated the point that he expects the bottom-up, legacy roadmapping processes and the strategic roadmapping organized through the Advanced Planning and Integration Office (APIO) to converge. The NASA Strategic Planning Council will decide on the final set of Agency-level goals.

In response to a question about the direction of education activities in the new NASA structure, Mr. Diaz described the role of the Education Officer in the SMD. In the past, the Office of Space Science and Office of Earth Science had different strategies for education, and both were successful. Mr. Diaz believes the education activities in the SMD will continue to be diverse. There is value in the space science approach of tying PIs and educators together, but he does not want that to be the only approach. An agreement has been reached with the NASA Office of Education on a joint appointment approach for a senior-level education position that will be part of the Office of Education staff but will manage SMD activities in education.

With respect to international interest in and concerns about the NASA reorganization, NASA is preparing to announce a dialogue with the international community. An international conference in March 2005 will provide a forum for discussing collaborations. In February 2005, there will be a series of meetings with NASA's Federal agency partners to focus on their interests and needs. There is also a conference in the spring of 2005 in Brussels on a "Global Earth Observing System of Systems." Mr. Diaz views that conference in the context of the longstanding discussions between NOAA and NASA on a global Earth observing system. The Brussels conference will focus on the operational aspects of such a system, where NOAA has the lead, with the research side being addressed during the March meeting sponsored by SMD. Dr. Asrar said that there is a planning process in place with other national and international entities, which will result in a draft national plan. The NASA research and development agenda will be a component of it. This draft national plan is expected to be ready for review in December 2004 or January 2005. The plan will be taken to Brussels as the initial U.S. position.

Dr. Jean-Bernard Minster asked if NASA would continue to commit resources toward the major challenges in acquiring, managing, and distributing the vast amounts of data from observing missions now in operation. Mr. Diaz replied that NASA is willing to discuss anything needed to implement the Exploration Vision. Although it may not be immediately obvious to everyone, he believes the data management issues that the Earth science programs have been addressing will emerge as key issues for the Exploration Vision objectives. For example the Sun-Earth Connection observing system is likely to move into that data management regime, where terabytes of data are being generated. Dr. Asrar added that NASA is working with other agencies on commitments for long-term archiving of data relevant to their missions. All this is being developed in the context of the Global Earth Observing System of Systems. Dr. Smarr asked how NASA's approach to doing science is being changed by the rapid growth in computing, networking, and other information technologies, particularly relative to the much slower development in areas such as space flight. Mr. Diaz replied that the technology changes Dr. Smarr mentioned have not escaped NASA's attention. The Agency is aware that these changes will affect how science is done. Mr. Asrar added that the class of science that is emerging depends on the availability and storage capability for data.

Dr. Jonathan Grindlay asked if the emphasis in the Exploration Vision on manned exploration and the need for resources to pursue its objectives, could support this direction in growth of science. Mr. Diaz replied that historically the "marriage" of human and robotic space science has been a driver for the Earth and space science robotics programs. He believes that the Exploration Vision will enable robotic exploration of the Moon and Mars and robotic astronomy and Earth science programs. He favors taking advantage of the opportunities provided by the Exploration Vision, rather than dwelling too much on parsing what the words of the Vision statement do or do not include. It is better to be proactive about the direction and move forward. The strategic planning process has every element of the community represented. Mr. Diaz is aware from past reorganizations that any change engenders concerns and anxieties. However, he views the future as providing even more exciting opportunities than in the past.

In response to other questions, Mr. Diaz said that the National Science Foundation (NSF) is one of the Federal agencies with which NASA will be working in preparation for the March conference. Although the transformation process was triggered by the report of the Aldridge Commission and the Exploration Vision, the process is now taking into account all the national priorities established in previous Presidential directives.

Dr. Asrar described his work with the Agency leadership on Exploration science priorities. He urged the science community to consider the situation as an opportunity to work with NASA in thinking about the role of science at NASA. The Vision is aimed at objectives that are 20 to 30 years in the future, which the science community can help to define. Not everything that is being done today should be dropped in order to move on, but it is important to put energy and effort into thinking about the future. One challenge is deciding how to divide the available energy and resources to ensure that ongoing activities are effectively executed and completed, while positioning NASA for the work of the future. At the Agency level, the SMD leadership is stressing the exciting possibilities for the coming decades offered by interdisciplinary efforts. These efforts are promoted by merging the Earth science and space science programs in one mission directorate. Another challenge in which Dr. Asrar is involved is defining the criteria for selecting the destinations for future NASA space missions beyond the Moon and Mars. He anticipates involving the science community in that decision process. The policy process, in which the Administration and Congress have significant roles, will continue over the coming months. The reorganization effort at Headquarters has been organized around three themes: strategy and implementation, communication and community involvement, and policy and process. The convergence of these efforts will define the Agency plan for the coming decades.

Panel and Discussion on Science Synergies

Dr. Mary Cleave, Acting Director of the Earth-Sun System Division; Mr. Andrew Dantzler, Acting Director of the Solar System Division; and Dr. Eric Smith of the Universe Division participated in a panel discussion on science synergies in the new SMD. (Dr. Anne Kinney, Director of the Universe Division, was engaged at Johnson Space Center with the launch of the Swift spacecraft.) In his comments to introduce the discussion, Dr. Asrar said that the SMD leadership wants to preserve programs and missions already in progress, but it is also seeking new opportunities. He iterated Mr. Diaz's emphasis on pursuing change deliberately, methodically, and inclusively.

Dr. Cleave described the combination of Internet announcements about Earth and space science grant opportunities in a new Research Opportunities in Space and Earth Sciences (ROSES) webpage, which will succeed the existing Research Opportunities in Space Science (ROSS). The

division has been examining synergies across programs in the techniques and technologies employed. Examples include modeling, supercomputing, and visualization techniques. To illustrate the synergies, Dr. Asrar said that the former Sun-Earth Connection Division would address issues such as what makes the Sun a variable star and what contributes to that variability, while the Earth Systems side studied the effects of the variability. The new Earth-Sun System Division is now looking at both the sources and the consequences of the variability, with the aim of understanding in order to predict.

Mr. Dantzler said that the Solid Earth program staff from the former Office of Earth Science has joined the Solar System Division to aid in disseminating research techniques from Earth science to investigations of other planetary bodies. Nuclear energy sources on planetary missions will allow more of these Earth-observing techniques to be used.

Dr. Smith noted that the Astrobiology Program in the Universe Division already has a number of Earth science investigations in progress. An area highlighted in the President's statement of the Exploration Vision was the search for Earthlike planets, and Dr. Smith anticipates productive interactions between the planet-finding community and scientists who study the Earth. The expertise of Earth scientists is also important in studying the evolution of planetary atmospheres, with the evolution of the Earth's atmosphere as one case. Laboratory-based astrophysics represents another area of interaction between space and Earth science. In the area of data management, he sees synergies for both areas in learning about programmatic aspects of extending data series over extended periods (longitudinal datasets). Dr. Asrar emphasized the role that the scientific leadership represented at the table could play in encouraging synergism, rather than a forced marriage of space and Earth science. The floor was then opened to questions and comments from the SScAC and ESSAAC members.

In response to a question on the scope of interdisciplinary research solicitations, Dr. Asrar said that a wide range of themes and topics could be considered, including theoretical, data mining, or observing projects. He gave some examples from the areas covered by the three divisions, such as looking at the Sun-solar system in the way that the Earth-Sun system has been viewed, or identifying common processes in the evolution of terrestrial planets. To establish and maintain a joint robotic and/or human presence throughout the solar system, it will be necessary to understand the conditions created by and altered by Sun-solar system interactions. Another example is defining the criteria for searching for Earthlike planets. Dr. Minster and Dr. Jonathan Lunine discussed the status of planetary coordinate systems for creating longitudinal time series of data analogous to the precision represented in Earth-observing datasets and geographical information systems (GISs).

The geodynamics program (Solid Earth) staff will be matrixed between the Earth-Sun System Division and the Solar System Division. Mr. Dantzler described the association as a logical next step in using instrumentation developed for observing Earth to observe other planetary bodies. Another topic discussed was commonality of techniques and expertise between the Earth Observing Systems Data and Information System (EOSDIS) and the Planetary Data System (PDS), particularly as future planetary observing missions such as the Mars Reconnaissance Orbiter (MRO) generate and transmit much larger volumes of data than preceding orbiter missions. One element of the reorganization was to extract parts of the data management organization and establish them as an entity not owned by a particular program. Mr. Diaz has asked Mr. Scott Hubbard to address the issue of how information technology (IT) and communications technology will change how NASA science is done.

In response to a question from Dr. Stephen Fuselier, Dr. Cleave said that the Earth-Sun System roadmap team has been explicitly asked to develop synergies. Dr. Smarr suggested that thinking about the capabilities of the next-generation autonomous robots could have major impacts on Earth science and planetary sciences, particularly if the science is considered from a combined point of view. Dr. Cleave noted that, for the Earth science side of such investigations, NASA would need to partner with other agencies that have the mandate to perform in situ investigations on Earth. The discussion of other potential areas of synergy led to discussion of the extent to which technology development for Earth science at NASA has been competed, compared with technology development for space science. Mr. Diaz and committee members discussed the aspects of Project Columbia that were competed and the collaborations of NASA centers with academic partners on IT.

Mechanisms for developing synergies through working with the science advisory committees were discussed. Dr. Jezek asked about preserving those areas in both Earth science and space science that do not have commonality across disciplines. An example is the capability that has evolved as Earth system science for feeding data into predictive models to enhance exploration and discovery. Earth system science has been pushing the integration of diverse data streams into a complex system model, and that aspect should not be lost in looking for commonality with solar system and planetary science. Dr. Heidi Hammel agreed with previous comments on the importance of establishing datasets for long-term monitoring of conditions on other planetary bodies. She also agreed with the value of considering Sun-planet connections more broadly, not just Sun-Earth connections. An example is following solar storm consequences at other planets than Earth. Her third point was that Uranus-size extrasolar planets are being discovered, but we do not know much about Uranus and Neptune. Mr. Diaz agreed that this was a good example of how knowledge has evolved over the past decade, while the set of NASA programs has not evolved to keep up with the new knowledge. He said that NASA and the SMD need to know from the science community when programs need to change to reflect new knowledge. Dr. Jack Mustard suggested consideration of procedures for fostering the interdisciplinary capability needed to support pursuit of scientific synergies. Workshops to explore areas of potential synergy were discussed. Dr. Roberta Johnson and Mr. Diaz concluded with the point that space science can also have implications for improving life on Earth.

Science Management Processes in the SMD

Dr. Paul Hertz, SMD Assistant Associate Administrator for Science, spoke with the committees by telephone about science management in the SMD. He began with a review of NASA Policy Requirement (NPR) 100.3A, which provides a charter for the SMD and its three science divisions. The aim of science management is to position NASA's science endeavors to support and benefit from the Exploration Vision. The science community provides input to the selection of science investigations and research programs through peer review of proposals and by establishing community standards for merit and priority. The community provides input to science management of flight missions and other programs (data analysis, data archiving, etc.) through working groups, science teams, steering committees, etc.

In response to a question, Dr. Hertz described the NRC study in progress to evaluate flight missions led by a Principal Investigator (PI). The study committee, which just held its second public meeting, has been asked to advise NASA on ways to improve PI-led missions such as those in the Explorer and Discovery programs. The objective is to improve the processes, not to change the roles played by the PI-class missions or to decrease opportunities for them.

Next, Dr. Hertz described the role of the division directors in program decisions and the charter of the SMD's newly formed Science Management Council (SMC). The SMC will meet on a biweekly schedule, as well as having ad hoc meetings as needed. Its charter is to provide advice, findings, and recommendations to the Associate Administrator for Science to enable the SMD to meet its strategic goals and objectives.

ROSES will become the vehicle for all NASA Research Announcement (NRA) solicitations from SMD programs. A "Dear Colleague" letter was distributed over Dr. Asrar's name during the week of November 8 to solicit opportunities for interdisciplinary scientific investigations in support of the Exploration Vision. To date, 15 white papers have been received in response to this letter. Solicited and selected interdisciplinary studies will be funded from the SMD budget.

Science Management Process Action Teams have been established internally to examine the processes used in the Office of Space Science and Office of Earth Science for lessons learned and best practices for use in the SMD. The teams are also responding to external studies and their recommendations. Among the processes being examined are those for managing research programs and flight programs. The product from these teams will be an SMD Management Handbook.

Dr. Hertz reviewed the current schedule of SMD solicitation and selections from November 2004 through May 2005. A ROSES omnibus NRA is being planned for 2005, as well as three Announcements of Opportunity (AOs) for the Earth System Science Pathfinder (ESSP) program, the Discovery program, and a medium-class Explorer (MIDEX) mission. The MIDEX AO is expected to be released around the middle of 2005 (early summer). Supplemental education and public outreach (E/PO) grants of up to $15,000 will be offered for every program in ROSES, whether in Earth or space science.

Discussion: In response to a question on streamlining the peer review process, Dr. Hertz said that he is aware of concerns about the process, but there is no current activity aimed at changing it. He said that the SMD needs to know if the community consensus is that the peer review burden is excessive. Dr. Smarr suggested that the NSF had similar issues and might be able to suggest potential solutions. Dr. Asrar welcomed any additional thoughts from the committees on the topics discussed and encouraged members to participate in the pre-proposal workshop on the interdisciplinary science opportunities, which is being planned for April 2005. Although the existing programs will continue as planned for the next year or two, the SMD and NASA will be seeking the help of the community in defining the role of science for the next several decades. Mr. Diaz added, in closing the discussion, that the NASA HQ staff members retain their total dedication to the future of the NASA science program and to its integrity and productivity.

Agency Strategic Roadmapping

Dr. Marc Allen is the Agency lead for Strategic Roadmap Development, as well as the SMD Assistant Associate Administrator for Strategy, Planning, and International. He began his briefing on strategic roadmapping with the post-transformation organization of NASA and the roles of the Associate Deputy Administrator (ADA) for Systems Integration and the Director for Advanced Planning. Both of these Agency-level positions are supported by the APIO. In particular, the Director for Advanced Planning is responsible for preparing 13 Agency-level strategic roadmaps for the Agency-level objectives and 15 capability (technology) roadmaps. Among its responsibilities, the APIO "coordinates development of strategies, roadmaps, and new initiatives, working with Mission Directorates and external advisory groups."

The 13 strategic roadmaps should have consistent contents and structure to simplify integration. Integration of the final planning products from the component strategic roadmaps is intended to create a unified NASA strategic architecture consistent with the Exploration Vision. This architecture will provide the basis for budget decisions, prioritizing initiatives, capability (technology) investments, facilities, human capital, and core competencies of the NASA Centers.

Dr. Allen discussed the list of 13 strategic objectives to which the 13 strategic roadmaps correspond. The NASA Strategic Planning Council, an internal senior management council chaired by the Administrator, is refining the wording of the strategic objectives. All 13 objectives are contained in the draft NASA Strategic Plan. The SMD may not prepare a separate strategy as the major NASA mission offices did in the past. Dr. Allen responded to members' questions on the relationship between the objectives, the Exploration Vision, and continuing activities.

Dr. Allen explained the process by which the 13 strategic roadmaps will be prepared. Legacy roadmapping activities (those underway prior to the transformation) are being merged into this new process to take advantage of the existing efforts and structures and to avoid confusing or irritating engaged stakeholders. The products of these in-place processes will be documented as the "initial plan" for an objective. The updated version produced by the strategic roadmapping panel will become the final version. The value added by the Agency-level roadmapping activity is ongoing integration across the roadmaps. The Integrated Strategic Architecture created through this new approach to strategic planning should have greater impact on budgets, initiatives, and the NASA Strategic Plan than the previous roadmapping structure had.

Each roadmap panel has three co-chairs approved by the Strategic Planning Council, plus a Directorate Coordinator selected by the lead directorate for the objective and an APIO Coordinator selected by APIO management. Dr. Allen thinks the success of the strategic roadmapping effort will depend on building close partnerships between the two coordinators on each panel. Integration of the 13 strategic roadmaps with the capabilities roadmaps into an Agency strategic plan will be a major challenge. Planning for the integration must be done even as the individual roadmaps are being developed concurrently. There are integration activities to be performed while the roadmaps are being developed, as well as on-completion integration of the finished roadmaps into a single unified exploration architecture. Dr. Allen has recommended that, because there are people from outside NASA on the roadmapping teams and transparency of the process is essential, the teams should be chartered formally as advisory committees under the Federal Advisory Committee Act (FACA).

Dr. Allen reviewed the current key milestones for completing the strategic roadmaps by July 31, 2005. The schedule includes submitting the individual roadmaps to the NRC for review on April 15, 2005, with the reviews due by June 1. A public meeting on the capabilities (technology) roadmaps will be held in Washington, D.C. on November 30, 2004.

In concluding, Dr. Allen said that the primary challenge in strategic roadmapping is not technical or scientific; the principal challenges are integration and commitment. Dr. Greg Williams added that extending the planning horizon of the roadmaps to 2035 will be a challenge in some areas. that have previously planned for a time frame of a decade.

SScAC/ESSAAC Reorganization Plans

Dr. Christensen explained the process that would be used to consider reorganization of the advisory committee structure for the SMD. After a presentation by Dr. Allen, the SScAC and ESSAAC members would divide into two breakout sessions, one to focus on organizational

issues for the advisory structure, the other to focus on process issues. Dr. David Spergel of the SScAC agreed to chair the breakout session on organizational issues. Dr. Smarr agreed to chair the session on process issues.

Dr. Allen provided an overview of the SMD plan for reorganizing the advisory committee structure. There will be one senior, FACA-chartered committee, called the NASA Science Advisory Committee (NSAC). The NSAC will have three subcommittees, each of which will have members whose expertise aligns with the program focus of one of the three SMD science divisions. The transition to the final structure will be gradual, and planning/roadmapping activities already in progress will continue. NSAC members will have three-year terms. A chair and vice-chair will be named from Earth and space science disciplines. The vice-chair will succeed the chair so that the chair position rotates every two years between Earth and space science. A vice-chair will serve two years in that position, then two years as chair. The NSAC and its subcommittees will each meet three times per year. As a starting point for the breakout discussions, Dr. Allen presented and discussed with the members one list of organizational issues and a second of process issues. Members asked about chartering the NSAC subcommittees under FACA, the rules governing subcommittee meetings, and the representation of Earth science disciplines on the three subcommittees and the NSAC. After discussion, Dr. Allen said that part of each NSAC meeting probably could be run as breakout sessions, to streamline review and consideration of input from its subcommittees. The NSAC will also be able to form task groups for specific purposes, as a means of developing input for its consideration. Dr. Allen suggested that a task group on technology would be the preferred way to provide a focus on technology needs for NASA science programs.

With the conclusion of discussion on Dr. Allen's presentation, the SScAC and ESSAAC members broke into the two teams to work on organizational and process issues.

Organizational Breakout Report and Discussion

When the plenary meeting reconvened, Dr. Spergel reported on the breakout session on organizational issues. The basic structure that the group recommended is three permanent subcommittees, corresponding to the three divisions of the SMD, plus a set of working groups. The subcommittee members should be selected to cover the specific science interests of the corresponding SMD division and for expertise in the working group topics (e.g., technology, education). Each of the NSAC-level working groups would be assigned one of the following topics: technology, education, data systems and IT, and exploration science coordination. The fourth of these groups might be established jointly with the Exploration Systems Mission Directorate (ESMD). The education working group would have two members with education expertise from each of the subcommittees, perhaps plus other members. The chairs of the working groups would be members of the NSAC. The working groups would typically meet a day or so before the NSAC meeting so that the chairs could report on the group's deliberations to the entire NSAC. The session participants were unanimously in favor of the three permanent subcommittees being chartered as FACA committees reporting to their respective division directors. There should also be a subordinate working group structure in each of the division subcommittees, each of which will be covering a large area and a significant program budget ($1.5 to $2 billion in each division). For instance, the Solar System Subcommittee could have the Mars Exploration Program Analysis Group (MEPAG) and analogous working groups for the Moon and the Outer Planets. The Universe Subcommittee would have the current Astronomy and Physics Working Group (APWG) and Science Archive Working Group (SAWG).

In the past, the SScAC was involved in synthesizing the roadmaps from its subcommittees into the Space Science Roadmap. That role no longer exists for the NSAC. The session participants were interested in finding a mechanism for the NSAC to have input to the strategic roadmaps, such as reviewing them while they are undergoing review by the NRC. With respect to numbers of members, the participants thought the ranges suggested by Dr. Allen were reasonable as a starting point. Each subcommittee should have at least two members involved with education. With respect to the relative numbers of Earth scientists and space scientists on the NSAC, the participants felt the proportion should depend on the questions that Mr. Diaz plans to bring to the NSAC for consideration. The NSAC will need to be structured to address issues that come before it.

Discussion: Dr. Fuselier said that the process session participants thought it would be good to have both the chair and co-chair of each subcommittee serving on the NSAC. Mr. Diaz urged the committee members to avoid focusing on ensuring representation by specific disciplines or interests. Dr. Spergel expanded on the rationale for having working groups like the MEPAG, APWG, and SAWG linked into the advisory structure so that their recommendations could be delivered through the NSAC as appropriate. On the question of having the Education Officer report jointly to the Associate Administrator for Science, Mr. Diaz explained that the Administrator prefers to have the Education Officer report administratively to the NASA Chief Education Officer. He agreed with the approach of including members with education expertise and involvement in the SMD advisory structure, as the session participants suggested. On the issue of chartering the subcommittees under FACA, Mr. Diaz favors having the formal advice to NASA coming from a single group so that NASA management is not left with deciding between conflicting or alternative recommendations. The strategic roadmap teams are not an exception to this principle because they do not continue beyond their assignments to produce a roadmap. Mr. Diaz added that there has never been more than one formally chartered advisory committee at the Associate Administrator level in either Earth science or space science. There was further discussion of the role of the roadmapping teams and the rationale for chartering them under FACA.

Process Breakout Report and Discussion

Dr. Smarr reported on the responses of the process session to the questions posed by Dr. Allen. After discussing the issue of formally chartering the subcommittees as FACA advisory committees, the group decided that the NSAC should begin operating and then address the issues on this point with NASA management. From a process viewpoint, the standing subcommittees provide continuity and disciplinary contact with their communities. The proposed organization maps the four current space science subcommittees into about two and a half of the new subcommittees, with all of Earth science constituting the remainder of the third subcommittee. Given the integration of Earth science and space science at NASA, the group thought it would be useful to look for Earth scientists who could bring relevant cross-linkages to the other two subcommittees (for the Solar System Division and Universe Division). This led to discussion of Dr. Allen's suggestion to divide the current ESSAAC membership between the NSAC and the Earth-Sun System Subcommittee. Dr. Smarr cautioned that some approaches to populating the new NSAC could create a sense of disfranchisement among Earth scientists. Possibilities for Earth science representation on the Universe and Solar System Subcommittees were discussed. Mr. Diaz expressed his interest in having many more generalists on the working groups for technology, IT and data systems, and education and outreach.

With respect to working groups of the NSAC, Dr. Smarr suggested that the ESSAAC subcommittees on technology and IT/data system be allowed to complete the work they are

currently engaged in, while broadening their membership to represent the three SMD divisions. Dr. Smarr, Mr. Diaz, and others discussed issues in having technology, IT, and education represented through task forces or more permanent entities and the extent to which these areas should meet as a group apart from the subcommittee structure. Mr. Diaz said it was not clear that a standing committee structure was necessary to provide input on these crosscutting topics. He iterated his opposition to establishing fixed representation of specific interests and disciplines.

The next process question was how topics for the NSAC are collected and defined. The process session participants thought that the reports from the subcommittees, with their suggested recommendations, should be available to the NSAC members at least two weeks in advance of the NSAC meeting at which they would be considered. The NSAC agenda will also need to be open to topics other than those brought forward from the subcommittees. Meeting agendas should be structured to focus on crosscutting or synergistic issues. On issues that a subcommittee has addressed in depth and are within its purview, a short presentation ending with the subcommittee finding or recommendation would be preferable to presenting and discussing the issue again at the same depth as during the subcommittee meeting. Issues that involve coupling of subcommittee or SMD division interests or that impact on programs beyond the purview of one subcommittee would require fuller discussion by the NSAC. The process session participants thought that the NSAC should meet three times a year for 2.5 days each, at least during the transition.

Discussion: The SScAC and ESSAAC members discussed how the area-specific recommendations from the subcommittees would go forward from the NSAC. Even if an issue is not broad enough for substantial NSAC attention, there should be a mechanism for it to go forward as formal advice from the NSAC. Mr. Diaz agreed that the SMD will be asking the NSAC to consider more crosscutting issues, with the subcommittees dealing with the area-specific issues. Dr. Garth Illingworth said that the NSAC would also need to become involved in issues involving controversy or a disparity between NASA's view and the view of the cognizant subcommittee. In the past, there has been an open process between the subcommittees and the SScAC. His experience is that the subcommittees have more impact on the outcome of major issues than the broad committee does. Dr. Spergel described the way in which the working groups have in the past reported through the space science subcommittees. Dr. Fiona Harrison commented that some degree of proportional representation on the advisory committees would be of value.

Dr. Christensen asked the leads of the two breakout groups to prepare draft language for inclusion in the SScAC letter to Mr. Diaz. The first day's session adjourned at 5:05 p.m.

Tuesday, November 16, 2004

Chairs' Remarks

Dr. Christensen reviewed the day's agenda. He noted that, during the day, he would make drafting assignments to the SScAC members for its letter to Mr. Diaz.

Universe Division Report

Dr. Eric Smith gave the briefing for Dr. Anne Kinney, Universe Division Director. He began with some of the recent science results from Kepler and other operating missions, including supernova remnants, globular clusters, and a new Milky Way–like galaxy. Significant events during the past quarter include continuation of transformation-related activities, activities related to Hubble Space Telescope (HST) lifetime extension, the 2004 Senior Review of proposed mission

extensions, and selection of proposals for Vision Missions and Origins Probes concept studies. The Formulation Authorization Document has been signed for the Beyond Einstein Program Office, which will allow the Laser Interferometer Space Antenna (LISA) project to enter phase A. A letter to the science community has been distributed to invite self-nominations for the Terrestrial Path Finder (TPF) Science Definition Team (SDT).

Key issues for the Universe Division include the launch of the Swift Gamma Ray Burst Explorer next week, HST optimization (to extend its operating life and optimize the science program), and the future of the Structure and Evolution of the Universe (SEU) programs, including Beyond Einstein. The ESMD has released a Request for Information (RFI) for a Hubble Robotic Servicing and De-Orbit Mission (HRSDM). Dr. Kinney plans to merge the Origins Subcommittee (OS) and Structure and Evolution of the Universe Subcommittee (SEUS) into one Universe Division advisory committee, which will meet part of the time in parallel sessions on SEU and Origins program activities. This would also be a good time to reorganize the working groups from the science community that support the Universe Division's programs.

Future activities of importance include a comparative review of the mission-specific Science Centers by a National Research Council (NRC) study committee. One objective of the review is to define lessons for future science center competitions. Results from a programmatic review of the Stratospheric Observatory for Infrared Astronomy (SOFIA) and from an expert review being conducted at Ames Research Center (ARC) should be available shortly. Dr. Smith noted a number of Intergovernmental Personnel Act (IPA) changes in assignments on the Universe Division staff. He then listed the co-chairs and coordinators for the two strategic roadmapping teams within the scope of the Universe Division. The SEU and Origins roadmap updates will provide the major part of the content for these Agency-level strategic roadmaps. To help with coordinating the two levels of activity, the two chairs of the roadmapping teams from the SEUS and OS have been appointed to serve on the strategic roadmapping teams as well.

Dr. Smith reviewed the missions in the current Origins roadmap and the scientific links connecting recent, current, and future missions. He summarized the rationale for a TPF coronagraph mission (TPF-C) in 2014, followed by an interferometer mission (TPF-I) in 2019. The TPF-I mission has strong support from the European Space Agency (ESA). In the planning for the Beyond Einstein program missions, the two missions currently in formulation, LISA and Constellation X (Con-X), will be followed by the Einstein Probes and missions still in the vision concept stage. LISA has "yellow" project status because of concerns in working out management agreements among the three partners: Jet Propulsion Laboratory (JPL), Goddard Space Flight Center (GSFC), and ESA. Con-X has "red" status due to the funding reductions in the FY 2005 budget request. Eleven Space Science Updates in the past year have been on results from Universe Division missions and science results. That two of the Space Science Updates were based on research and analysis (R&A) grant results illustrates the importance of R&A to broader NASA goals. Dr. Michael Werner added that the discovery of Sedna was also primarily an R&A effort. Media teleconferences are proving successful in drawing large audiences of science journalists.

All operating missions in the Universe Division are performing well (overall status is "green"). Among the developmental missions in the Origins programs, there are continuing concerns with SOFIA, the Keck Interferometer, the Space Interferometry Mission (SIM), and the James Webb Space Telescope (JWST). Although there were technological challenges that SOFIA had to overcome, Dr. Smith described the problems as largely programmatic. He discussed with the members the reasons for and implications of the delay in U.S. approval for use of an Ariane rocket to launch JWST. Among SEU developmental missions, the Gamma ray Large Area Space

Telescope (GLAST) is experiencing cost increases and schedule problems with its principal instrument, the Large Area Telescope (LAT). The problem with charge-coupled device (CCD) bonding for the Planck mission has been solved, and the project is trying to make up the delay in production. ESA is still trying to find an alternative approach to continue the Extreme Universe Space Observatory (EUSO) project. The mission has changed so much that NASA will require that this Explorer mission of opportunity be reproposed.

The historical trend chart for Guest Observer and R&A funding, by mission, was presented and discussed. This version includes some updates and revisions from the chart shown at the July 2004 meeting. The total funding for FY 2005 will be about $140 million. Dr. Smith also presented budget, guest observer numbers, and numbers of proposals received for the science centers associated with the HST, Chandra X-ray Telescope, and Spitzer Space Telescope.

Discussion: Because of budget uncertainties, the Einstein Probes do not yet have a schedule. Announcement of the selection of small Explorer (SMEX) missions from the last competition is also delayed until the FY 2005 budget is approved. With respect to primary mirror production for JWST, segments 1 through 10 of 18 total have been produced. Dr. Smith said he would check on the status of Gravity Probe B (GP-B) in light of the spacecraft's safe mode event in October. In response to a question on involvement of Earth scientists in the search-for-life portions of the Origins roadmap, Dr. Smith said that there are astrobiologists involved but additional involvement of Earth scientists is desirable. In the Universe Division Roadmap, there will be separate parts for specific SEU and Origins program areas, as well as areas that will be merged to cover both areas.

Solar System Division Report

Mr. Andrew Dantzler, Acting Director of the Solar Systems Division, began with highlights from the past quarter, including the launch of the Mercury Surface, Space Environment, Geochemistry and Ranging (MESSENGER) mission on August 2, the landing of the Genesis sample return capsule on September 8, and Cassini's passage within 1,200 km of Titan. The Deep Impact spacecraft has been shipped to Cape Canaveral and is being prepared for a December 30 launch. Both Mars Exploration Rovers (MERs) have survived the martian winter. Kepler completed its preliminary design review (PDR) and is preparing for critical design review (CDR) on December 3. The Discovery/New Frontiers Program Office has been moved from JPL to Marshall Space Flight Center (MSFC). After the FY 2005 budget appropriations are passed, selections will be announced for Mars Science Laboratory (MSL) instruments, the Lunar Robotic Orbiter (LRO), and the Discovery program.

Among major concerns and issues for the division, the schedule for the New Horizons mission to meet all its requirements remains very tight. Because of the stand-down at Los Alamos National Laboratory, the plutonium already provided for the radioisotope thermionic generators (RTGs) will be all that the mission will have. The reliability problem with field-programmable gate arrays (FPGAs) is affecting many missions in development. There are also issues with launch vehicle qualification and certification for New Horizons, and the Ralph mapping spectrometer and camera is late by several months. The New Horizons project office has been tasked to form an independent assessment team to determine readiness for a January 2006 launch. The team will report by mid-January 2005.

A major issue is whether Project Prometheus power and propulsion concepts will be developed in time to meet the mission requirements for the Jupiter Icy Moons Orbiter (JIMO). The first Prometheus-powered mission may be a demonstration of nuclear electric propulsion, with the

second Prometheus being the JIMO spacecraft. If the JIMO primary science requirements are not met with Prometheus, the Solar System Division will consider returning to the earlier Europa orbiter concept in place of JIMO. Members asked Mr. Dantzler about the direction being taken by Project Prometheus and the implications for a JIMO mission.

Upgrades and restructuring of the Deep Space Network (DSN) and the Deep Space Mission System (DSMS) need to start as soon as possible to support future Solar System Division missions. Dr. Rocky Kolb said that the mission requirements driving the aggressive upgrade plan for the DSN had not been clear from the presentation on the DSN Roadmap to the OS and SEUS. Dr. Kolb and Dr. Spergel recommended that the SScAC (or its successor) be briefed on the DSN roadmap, the upgrade options for the DSN, and the cost implications for the various categories of potential users. Programmatically, the DSN budget is carried in the Solar System Division.

The program status chart for the Discovery program is "yellow" because of specific project overruns, including the cost and schedule issues with Dawn and Kepler. However, Mr. Dantzler judges the program generally to be healthy. The cost cap for Discovery missions may be increased. The next Discovery AO is planned for release in February 2005. In the New Frontiers program, two missions are in competition to become the second mission (after New Horizons). Project management for the PDS is being kept at JPL for 6 months to give JPL a chance to restructure its management of the project. After 6 months, a decision will be made on whether to keep project management there or move it. Another issue is timely availability of funds for researchers awarded R&A grants. Much of the problem appears to stem from delays caused by extended congressional Continuing Resolutions, which constrain release of grant award funds. With respect to technology development, an integrated plan and a budget are needed to provide the technology for Solar System Division missions.

Issues for the Mars Exploration Program include the problem of whether to deploy the antenna on the Mars Advanced Radar for Subsurface and Ionospheric Sounding (MARSIS) instrument on the Mars Express orbiter. The risk of deploying the antenna is still being modeled. The next opportunity to deploy the antenna is in March 2005. The Mars Reconnaissance Orbiter (MRO) spacecraft was disassembled (de-integrated) to replace its FPGAs with new-generation arrays. A readiness meeting next week will determine if the MRO schedule must be extended. Planetary protection is still an issue for the MSL. The useful life of the MERs will continue long enough that funding the extended mission will become a budget issue for the Mars Exploration Program.

With respect to the crash landing of the Genesis sample return capsule, the guidance and navigation of the spacecraft up to capsule release were excellent. When the parachute failed to deploy, the capsule landed at 200 mph. Mr. Dantzler reviewed the recovery status of the sample collectors. The biggest concern is the array wafers, of which only 10 percent of the total collector area has been recovered thus far. The primary cause of the Genesis landing mishap does not apply to the **Stardust** sample return, which remains on schedule for January 2005.

Discussion: In response to Dr. Christensen's question on technology development funding, Mr. Dantzler said that much depends on the final FY 2005 appropriations. The near-term technology requirements for the Solar System Division's missions are covered, but something like the former Mission and Science Measurement technology development program is needed. Dr. Smith added that technology development is also a concern for the Universe Division. A program is needed to advance detector and information technology in the mid-Technology Readiness Level (TRL) range.

Dr. Harley Thronson of the SMD staff estimated that the loss to the SMD from the reorganization of technology development formerly resident in the Office of Aerospace Technology amounts to $100 to $150 million per year under full-cost accounting. About 150 tasks were lost that are essential for future missions. That funding is now being directed to the Constellation Program and the Crew Exploration Vehicle (CEV) in the ESMD. Unless there is some way to compensate for this technology development loss, the impact will be felt primarily on missions planned for a decade from now. An option that the SMD is pursuing is to emphasize these technology needs in the Agency-level capability roadmaps. These comments led to discussion by the committee members and SMD staff on how the capability roadmaps will be aligned with the strategic roadmaps, and how to highlight the disconnect between funding for technology development and preparation for space missions.

Earth-Sun System Division Report

Drs. Mary Cleave, Jack Kaye, and Richard Fisher of the Earth-Sun System Division gave sections of the briefing. Dr. Cleave explained the rationale for viewing the Earth-Sun interactions as a system in terms of three forcings that affect conditions on Earth: the Sun and beyond, the natural variability of Earth, and human activities. To understand the future evolution of this system, the sequential scientific capabilities of characterizing, understanding, and predicting are needed. As part of the characterization activity, a large number of satellites observe the heliosphere and the Earth from space and in Earth orbit.

Earth-Sun science is an end-to-end program that uses science for society's benefit. The division is engaged in many partnerships with other Federal agencies. It oversees the largest part of the multi-agency Climate Change Research Initiative (CCRI). A recent addition to this partnership is the new Interagency Working Group on Earth Observations (IWGEO), which reports to the Environment and Natural Resources Committee of the National Science and Technology Council (NSTC). There are established interagency strategic plans for the CCRI, IWGEO, and the U.S. Weather Research Program (USWRP). In response to a question, Dr. Cleave said that the interagency activities influence the programs in the division but do not control the research direction. She also expanded on the long-term partnership between NASA and the National Oceanic and Atmospheric Administration (NOAA) for developing and expanding the capability of weather and environmental observing satellites. At present, there appear to be different priorities expressed by the research and operational arms of NOAA on certain weather observing technologies, such as extension of the Tropical Rainfall Measuring Mission (TRMM).

Dr. Jack Kaye, Director of Earth Science Research, described the progress that has been made in a number of areas in moving along the continuum of characterization, understanding, and prediction in Earth system science. The trends in ozone loss rate have been observed using time series data sets from three instruments: the Stratospheric Aerosol and Gas Experiment (SAGE), SAGE II, and the Halogen Occultation Experiment (HALOE). The launch of the Aura spacecraft in July 2005 completed the first generation of Earth observing satellites. Aura's Tropospheric Emission Spectrometer (TES) can provide three-dimensional profiles of moisture in the troposphere and stratosphere. The TES data on the tropospheric ozone column are being compared with model predictions of tropospheric ozone. The laser altimeters on the Ice, Cloud and land Elevation Satellite (ICESat) provide data on changes in polar glacier elevations, which are useful in characterizing and understanding climate change. The third and final set of laser altimeters on ICESat is now being operated on an intermittent schedule to get time series data of the most value. Information on terrestrial water storage is being derived from observations made by the Gravity Recovery and Climate Experiment (GRACE) satellite, which uses gravitational field remote sensing to detect seasonal changes in local density. The next Earth observing

instruments to be launched are the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) and CloudSat.

Dr. Kaye described how the near-simultaneous observations from a number of instruments on different platforms provide benefits in relating atmospheric parameters of interest, such as studying atmospheric aerosols. An important consideration is creating and maintaining consistent time series of observations across successive missions that incorporate generational changes in the instruments performing the measurements. Once the research on observing methods and interpretation of the data has matured, NASA also works on transitioning observing capability from NASA experimental platforms to operational platforms, such as the NOAA geosynchronous and polar-orbiting Earth-sensing satellite systems. Many of the measurements now being made by instruments on Aqua and Aura will transition to NOAA's National Polar-orbiting Operational Environmental Satellite System (NPOESS). For some other measurements being made with the current Earth-observing fleet of satellites, there is not yet an identified successor instrument or platform. With respect to transitioning research on data interpretation and data assimilation into models, the division is working with NOAA through the Joint Center for Satellite Data Assimilation at GSFC and the Short-term Prediction Research and Transition Center at MSFC.

Discussion: Dr. Cleave and Dr. Kaye answered questions about LandSat continuity and eventual commercialization in accordance with the LandSat Act and about the timing for NOAA's transition to NPOESS. In response to a question on the use of Project Columbia computing capability for Earth observing data, Dr. Kaye said that, given the investment made on observing systems, NASA wants to be get the data into data assimilation systems so that it can be used more widely and effectively. Project Columbia will provide increased flexibility and capability for these objectives, but there are more opportunities than can be pursued within budget constraints.

Dr. Richard Fisher reviewed the programs inherited from the Sun-Earth Connection Division. The NRC's decadal survey, *Sun to Earth and Beyond*, and the 2003 Sun-Earth Connection roadmap are the guiding documents for the programs. The strategic goal is to "understand how the Sun, heliosphere, and the planets are connected in a single system." Under this goal are three strategic objectives: (1) explore the fundamental physical processes of plasma systems in the universe, (2) understand the changing flow of energy and matter throughout the sun, heliosphere, and planetary environments, and (3) define the origins and societal impacts of variability in the Sun-Earth connection. An important part of the third objective is to discover and understand the connection between solar phenomena and geospace disturbances, such as the electrical currents in the Earth's atmosphere that modulate radio waves. Dr. Fisher illustrated the societal importance of the solar phenomena with the effects of the large coronal mass ejection (CME) in November 2003 on the Earth's ionosphere and on spacecraft in Earth orbit or in deep space.

The Solar Terrestrial Probe (STP) science missions include Solar-B, a joint mission with Japan that has been delayed to 2005, and the Solar Terrestrial Relations Observatory (STEREO), which is in its integration and test phase. The first planned mission in the Living With a Star (LWS) program is the Solar Dynamics Observatory (SDO). The major risks to the SDO mission have been retired, and the spacecraft will launch on an Atlas V rocket.

The Community Coordinated Modeling Center is a multi-agency partnership to enable, support, and perform the research and development for next-generation space science and space weather models. Dr. Fisher gave examples of how improved warnings of solar weather events could protect future spaceflight operations near the Earth and within the Earth's radiation belts, in lunar orbit or on the Moon's surface, and in interplanetary space beyond the Moon. He then reviewed the schedule of planned missions to sustain the Sun- and heliosphere-observing fleet of satellites.

A Senior Review next year will decide which missions can be continued and which will be terminated. Dr. Fisher believes the planned missions will provide substantial value to Exploration Vision missions.

Dr. Fisher will report in more detail on the Sounding Rocket Program at the next SScAC (or successor) meeting. A review board for the program has met and is preparing its findings and recommendations.

Discussion: On future STP missions, Dr. Fischer said there will be a downselect in the next few months for the Magnetospheric Multiscale (MMS) mission. Two additional missions in the roadmap for STP, the Geospace Electrodynamics Connections (GEC) and the Magnetospheric Constellation (MAGCON), are beyond the budget planning horizon and their fate is in question. The Solar Probe mission has a Science and Technology Definition Team but no funding at present for further planning or development. Dr. Cleave said that, with respect to decisions on the Landsat Data Continuity Mission (LDCM), an interagency working group on the issue is waiting for a decision from the Administration.

In closing the presentation, Dr. Cleave reviewed the questions that have been asked of the NRC study committee that is currently conducting the first decadal survey for Earth System Science. The first report is due in March 2005, and the results will be integrated with the strategic roadmapping process. An external committee is continuing to work on the evolution of the EOSDIS into a more distributed system.

Project Columbia is a partnership between NASA and industry to significantly enhance national computational capability. It will be a national asset available to multiple agencies through a competitive process. For NASA, it can provide a tenfold increase in computing capacity and includes a networking component to connect the NASA centers for scientific research.

Lunch with Science Talk "Early Results from Cassini"

Dr. Linda J. Spilker, the Cassini Deputy Project Scientist, presented science highlights from the Cassini mission. Cassini, which is just beginning its four-year tour of the Saturn system, is an international mission involving 17 countries. Dr. Spilker described the science roles of the twelve science instruments on the orbiter and the six instruments on the Huygens probe. Cassini is powered by three RTGs. The seven-year cruise from Earth to Saturn was accomplished with multiple planet flybys for gravitational assist. Cassini has already found water ice and carbon dioxide ice on Phoebe, and Dr. Spilker presented Phoebe imagery and spectroscopy results. She discussed the organization and composition characteristics of the Saturn ring system as observed by Cassini so far. Another feature of interest is the haze layer above Titan.

SScAC Separate Session

SEUS Report and Action Requests

Dr. Rocky Kolb, SEUS chair, presented the SEUS report from its joint meeting with the OS on November 8–9, 2004. He summarized the main points of interest to the SScAC and the SEUS from each of the presentations. With respect to the DSN Roadmap, the SEUS members' principal concern was that communications from the L2 Lagrangian point, where many future SEU missions are likely to be located, did not appear to be a major consideration in the capability planning. (See letter from the SEUS chair to the SScAC chair, Appendix G.)

Dr. Kolb summarized the report from the balloon program roadmapping team. The current balloon program includes short conventional flights, long-duration flights from Antarctica or Alaska, and flights from Australia. The SEUS thought that the team did well in relating the roadmap to NASA's larger strategic objectives and in presenting the technology development and scientific education roles of ballooning. Balloon payload complexity, size, and cost have increased over time. At present, balloon missions compete as missions of opportunity (MOOs) in SMEX and MIDEX AOs. The roadmapping team recommended that a "university-class" Explorer (UNEX) AO would give balloon proposals, particularly those of larger complexity and cost, the chance to compete with missions in the same cost range. The SEUS recommendation to the SScAC is that NASA study the potential advantages and disadvantages of issuing a UNEX AO under the current Explorer guidelines.

Discussion: Dr. David Spergel said that a concern of the OS about the balloon team's suggestion was the impact on timing of future Explorer AOs if a UNEX AO is added. Dr. Fiona Harrison agreed with the balloon team's assessment that reviewing small MOOs, like the balloon projects, as part of the same review as a full MIDEX competition puts the balloon proposals at a disadvantage. The SScAC members discussed alternative ways of establishing a mechanism for balloon science projects to compete for funding.

OS Report and Action Requests

Dr. David Spergel, OS chair, presented the recommendations proposed by the OS for SScAC consideration. (See letter from the OS chair to the SScAC chair, Appendix E.) The first recommendation concerns the JWST program and the issue of approval for use of an Ariane launch vehicle. With respect to the modified TPF program, the OS discussed a letter from the NRC's Committee on Astronomy and Astrophysics (CAA), which criticized the intent to direct 50 percent of the mission to observations related to general astrophysics. The OS recommendation was that TPF-C be given a higher priority than TPF-I in funding because of the importance of getting TPF-C technology ready for a 2014 launch. The OS recommendations for the upcoming AO for TPF-C instruments were that general astrophysics should be represented on the Science and Technology Definition Team and that two or more general astrophysics instruments should be selected for study (phase A). In response to a question, Dr. Spergel said that these recommendations were within the context of supporting the primacy of the planet-finding mission for TPF, including TPF-C.

At the request of the SScAC chair, Dr. Wendy Freedman, the chair of the CAA, summarized the position of the CAA on TPF-C. The CAA approves of the science objectives defined for TPF and views TPF-C as a strong complement to TPF-I because of the synergy between observations in the optical and infrared ranges of the spectrum. The CAA was concerned that addition of general astrophysics observing capability to TPF-C not drive the project's cost. Another concern was that the definition of a TPF-C mission in addition to the TPF-I mission was proceeding without the kind of community involvement and science review represented, for example, in the Decadal Survey process. The CAA has recommended a mid-term review to review the balance across the spectrum of missions, but not to reset the priorities of the most recent Decadal Survey.

Dr. Spergel next presented the OS recommendation on HST refurbishment options. The OS recommended the involvement of the science community in evaluating the trade-offs between HST costs and the opportunity cost for other missions. The SScAC discussed the way in which the community should be involved and the timing of the involvement to be meaningful in NASA's decision process. The members agreed that the wording of the recommendation as proposed by the OS should be more specific about the form of the involvement. The last OS

recommendation discussed by the SScAC addressed the importance of an education officer for science with a strong working relationship with the Associate Administrator for Science, even if the education officer reports administratively to the NASA Chief Education Officer.

SECAS Report and Action Requests

Dr. Michelle Thomsen, chair of the Sun-Earth Connection Advisory Subcommittee (SECAS), began her report with highlights from the Sun-Earth Connections Workshop, held November 8–12 in Merida, New Mexico. The workshop's topics and the wide-ranging expertise of its participants typify the extent of connections across Sun-Earth and Sun–planetary system science. Some of these connections were illustrated by a major solar event on November 7, 2004, which resulted in strong coupling of the passing plasma cloud with the Earth's ionosphere and disruption of operations by the Chandra and GP-B spacecraft.

The SECAS meeting on November 3–5 emphasized learning about Earth system science activities in the new Earth-Sun System Division and about the strategic roadmapping activities. Dr. Thomsen presented the findings and suggested recommendations from the SECAS to the SScAC. (See letter from the SECAS chair to the SScAC chair, Appendix F.) The SScAC discussed and suggested revisions to the proposed recommendations. There was extended discussion about an appropriate wording for a recommendation on Explorer competitions to include balloon project proposals. Dr. Christensen assigned members to draft revised language for the revisions, to be reviewed during the Wednesday session. The subcommittee chairs and other SScAC members discussed the process for approving or revising recommendations in the subcommittees' letters that are specific to one subcommittee's scope.

Report from the Astronomy and Astrophysics Advisory Committee (AAAC)

Dr. Garth Illingworth, chair of the AAAC as well as an SScAC member, began with the history of the committee's formation. It was established by Congress in August 2002 in response to concerns of the Office of Management and Budget (OMB) and Congress about duplication in Federally funded research in astronomy and astrophysics. Another influence on its formation was the report by the Committee on the Organization and Management of Research in Astronomy and Astrophysics (COMRAA), a committee of the NRC tasked with reviewing the processes and programs of both NASA and the NSF. The current form of the AAAC was established in November 2003, with 13 members from its original membership, plus members selected by NASA, NSF, and the Office of Science and Technology Policy (OSTP). The AAAC must submit an annual report to Congress and the participating agencies each year by March 15. As of March 15, 2005, the role of the Department of Energy (DOE) will be formalized with new AAAC members nominated by the DOE.

The AAAC sees itself as focusing on implementation of Decadal Surveys and other comparable NAS/NRC reports. The Decadal Surveys are critical because they are based on a bottom-up survey of the science community and include specific implementation recommendations. Other guiding documents are the NRC report, *Connecting Quarks with the Cosmos*, and the report of the Interagency Working Group on the Physics of the Universe, under the National Science and Technology Council, titled *A 21st Century Frontier of Discover: The Physics of the Universe*. The latter two reports were instrumental in helping to form the Dark Energy Task Force, a joint subgroup of the AAAC and DOE's High Energy Physics Advisory Panel (HEPAP).

The March 15, 2004, report of the AAAC includes broad recommendations for implementation of science programs and specific recommendations for programs recommended in the NRC Decadal survey. One broad recommendations on NASA's programs addressed the science impact of the

Administrator's decision in January to cancel the Shuttle servicing mission to the HST. The second broad recommendation on NASA programs addressed the impact of the FY 2005 budget funding profile on the SEU missions constituting the Beyond Einstein program: Con-X, LISA, and the Einstein Probes (particularly the Joint Dark Energy Mission, JDEM). For the NSF, the recommendations stressed the high priority programs in the Decadal Survey and the complementary and synergistic role of ground and space-based observing platforms.

The AAAC's current activities center around the four formal meetings held each year. This year it endorsed the efforts by the science working groups (SWGs) for NSF's Giant Segmented Mirror Telescope (GSMT) and NASA's JWST to identify complementary and synergistic science goals and capabilities. The Cosmic Microwave Background Radiation (CMBR) task force, which represents the DOE, NSF, and NASA, was set up in early 2004 to develop a joint roadmap for polarization studies and long-range programs. The task force report is due to be released in early 2005. A major AAAC effort this year has been to set up the Dark Energy Task Force. Dr. Illingworth concluded with comments on the relationship of the AAAC to other advisory committees. Because its focus is on the status of Federal activities to implement the NRC Decadal Surveys and other NRC studies, interaction is needed between it and the CAA. There should also be continuing information exchanges with other FACA committees advising the three agencies, including the SScAC or its successor.

Discussion: When asked if the AAAC would address the change in Project Prometheus support for the JIMO mission, Dr. Illingworth said the committee has to focus on the broadest concerns where it can have a useful impact. This led to extended discussion of the purview of the AAAC with respect to science disciplines other than astronomy and astrophysics and with respect to the Agency-specific programs that do not involve major elements of interagency cooperation or coordination.

Solar System Exploration Subcommittee Report

Dr. Jonathan Lunine, chair of the Solar System Exploration Subcommittee (SSES), reviewed the findings and proposed recommendations from the SSES meeting in October 2004. (See letter from the SSES chair to the SScAC chair, Appendix H.) The SScAC discussed the proposed recommendations and potential revisions suggested by members. Dr. Christensen made assignments to draft language for recommendations accepted by the SScAC. The SSES finding on the Discovery Program was discussed in terms of whether the SScAC should comment on the program now or in the future. Dr. Lunine presented and expanded on the SSES finding and recommendation on JIMO and Project Prometheus. Other SSES findings or recommendations addressed administrative changes in the Solar System Division and the SMD, the Discovery Program, JIMO and outer planets science missions, the PDS, development support for new technologies to enable planned Solar System missions, and the Mars and Moon exploration programs.

After the SScAC discussion of the recommendations proposed by the SSES, Dr. Christensen reviewed the assignments to members for revisions of recommendations proposed by the subcommittees or drafts of new recommendations to be formulated by the SScAC. The two chairs of the Monday breakout sessions on organization and process for the SMD advisory committee structure will draft summaries of the results from their sessions.

SScAC–ESSAAC Joint Session
General Discussion

At 4:30 p.m., the visiting members of the ESSAAC rejoined the SScAC meeting to discuss issues of common interest to the two committees.

Hubble Servicing and De-orbit Options. Dr. Spergel summarized the options for the HRSDM presented to the OS at its November meeting. In response, the OS proposed a recommendation that the science community evaluate the science value of an HRSDM in the context of the broader program of NASA science missions. The committee members discussed wording to communicate the interest of the science community in the HRSDM decision process. Dr. Jennifer Wiseman, HST Program Scientist, described some of the context of the HRSDM, such as the cost of Shuttle Return to Flight and the role that has been assigned to the ESMD in performing the mission. She and committee members discussed the ESMD decision process and other Agency objectives for the mission besides the science value of the HST.

ESSAAC Issues for Joint Consideration. Dr. Minster presented the set of issues that the ESSAAC members had identified as important for continuing joint consideration by the two committees or by the combined successor committee. These issues include E/PO, technology development to support program science objectives, IT, and data and information systems. As an example of the last issue, one option that could be considered for the PDS is to move to a next-generation system, which could solve the problem of connection speed between PDS nodes.

Other ESSAAC Discussion Topics. During their separate session, the ESSAAC members discussed the draft strategic plan for Earth system science and issues with the Landsat Data Continuity Mission. A general difference between the Earth science and space science programs is that those working on Earth system science have been thinking in terms of measurements needed, rather than missions (platforms). With the NASA transformation, the question of future Earth system science missions must be addressed in terms of what missions would benefit both communities (Earth science and space science). One suggestion from the ESSAAC members' discussion is a mission to the L1 Lagrangian point that would carry instruments to study the Earth, Moon, and space weather. The strategic planning approach used by the former Office of Earth Science differed from the use of Decadal Surveys by the Office of Space Science.

Discussion: Mr. Martin Kress of the SScAC asked Dr. Minster how he sees the priorities for Earth system science being established in the future. He noted the strong integration of the Earth science programs with the operational missions of other agencies and the pressure on the Earth science community to be relevant to major national priorities such as drought prediction. He asked how this context might affect the transfer of measurements made now by the current complement of EOS operational missions to NPOESS. Dr. Minster said that these questions are ones the ESSAAC members and the community are considering and discussing in depth. In any case, NASA does have unique contributions to make in studying the Earth and addressing issues of national importance.

The discussion turned to formulation of the new NSAC as the successor to both the SScAC and ESSAAC and the distribution of membership from the Earth science and space science communities. The Tuesday session ended at 5:30 p.m.

Wednesday, November 17, 2004

Discussion with the Associate Administrator

Mr. Diaz joined the members of both committees to discuss the meeting's presentations and topics of interest. Dr. Christensen led the discussion with Mr. Diaz on the advisory committee structure. The new NSAC should continue to play a role in the legacy roadmapping activity, and the SScAC or the NSAC should participate in a meaningful role in the strategic planning process for science. Another SScAC suggestion is a joint working group with the ESMD to define science opportunities that could support exploration. Mr. Diaz agreed with this suggestion, which would support Dr. Asrar's role in coordinating with the ESMD.

Dr. Minster said that the members of the ESSAAC support the effort to merge the two advisory committees. NASA Earth science was already addressing Presidential priorities through the Climate Change Science Program and the Global Earth Observing System initiative. The Exploration Vision is a third priority to be considered. Dr. Minster said that the focus of advisory input should be on the roadmaps that are being prepared. The ESSAAC members also favor interdisciplinary representation, including Earth science, on all the subcommittees of the NSAC. Dr. Minster sees a growing convergence of views between the two communities. Dr. Christensen noted some evident interdisciplinary opportunities, such as Sun-solar system activities and the search for life.

Dr. Christensen conveyed the members' concern that there should be a senior education officer for science with strong connections to Mr. Diaz's office. This person should have a science background, and Mr. Diaz should be actively involved in the selection. Mr. Diaz responded that part of the agreement with the NASA Chief Education Officer is that the education officer for science have a background in science and will report to both the Chief Education Officer and Mr. Diaz. He said it would be useful for the SScAC to confirm those characteristics of the position that it believes are important.

With respect to the SScAC/NSAC role in strategic planning, Mr. Diaz said that the NASA Director of Advanced Planning recognizes that the formal advisory committees need to be involved in reviewing the strategic planning products. It would be useful for the SScAC to endorse or comment on the planned approach to linking the legacy roadmapping process with the Agency-level strategic roadmapping.

Dr. Minster said that the ESSAAC members noted differences from the space science approach in the previous strategic planning approach in Earth science. For instance, Earth science planning must consider interagency partnerships and developing opportunities for involvement of the private sector. Areas of overlap include interest in time series of data. Both communities are studying complex systems for which models are needed that can incorporate large data streams. An Earth system science concept that could be adopted to studying the Sun and solar system is to make measurements "everywhere, all the time." Mr. Diaz noted a similar concept in the strategic planning to make all of Mars accessible all the time. As examples of other areas where Earth science and space science could take an integrated approach, Dr. Minster cited UAVs and balloons as observing platforms. Also, robots could be used for investigations on Earth as well as in space. A common organizing theme could be the movement of energy from the Sun to Earth and what happens after solar energy reaches the Earth.

Mr. Diaz said that areas of integrative science would be helpful for showing the positive aspects of the NASA transformation. With respect to a strategy for dealing with technology investment,

the SMD will use the capability roadmaps to examine technology needs, current funding, and gaps in capabilities. He discussed with the committee members how mission-specific technology needs would be identified and funded. He agreed that development for low-TRL technology that is not specific to a program is more difficult to sustain. Dr. Christensen noted the difference between mission-specific near-term technology requirements and longer term needs a decade or more in the future. The SScAC would like to hear more about how the long-term technology needs are being met. Dr. Minster added that further information about Project Columbia would be useful, particularly the capability it offers for NASA science. Dr. Killeen reported on a meeting of SECAS members and ESSAAC members on Tuesday evening, at which several important ideas and themes of common interest were identified. Among these were the L1 Lagrangian point for observing platforms and use of LEO combined with precise pointing capability.

Other issues that were discussed with Mr. Diaz were the importance of the Ariane launch vehicle approval for keeping JWST development on schedule and within cost, high-level participation of the science community in evaluating the science trades of an HRSDM, and the way in which public affairs issues will be handled in the SMD. In response to a question on the relationship of NASA's science mission to the human spaceflight program, Mr. Diaz emphasized the interdependence among elements of NASA. He said that the other directorates recognize that science is a major NASA product. Mr. Diaz thanked the retiring members of the committee, including Dr. Christensen, and joined the staff in recognizing their contributions during their tenure on the SScAC.

Dr. Christensen adjourned the meeting at 11:15 am.

AGENDA
SPACE SCIENCE ADVISORY COMMITTEE
November 15–17, 2004
Marriott Newport Beach
Irvine, California

November 15, 2004

8:30	Welcome and Agenda	A. Christensen L. Smarr
8:45	NASA Science Programs Transformation	A. Diaz G. Asrar
10:15	BREAK	
10:30	Panel and Discussion on Science Synergies	E. Smith A. Dantzler M. Cleave
11:30	Science Management Processes in SMD	P. Hertz
12:00	LUNCH	
1:00	Agency Strategic Roadmapping	M. Allen
1:30	SScAC/ESSAAC Reorganization Plans	M. Allen
2:00	Break-out Session on Integrated Committee	
	1. Organizational Issues	TBD
	2. Process Issues	TBD
3:15	BREAK	
3:30	Organizational Break-out Report and Discussion	TBD
4:15	Process Break-out Report and Discussion	TBD
5:00	Wrap-up Discussion	A. Christensen L. Smarr
5:30	ADJOURN	
7:00	Joint Committee Dinner	

November 16, 2004

8:30	Chairs' Remarks	A. Christensen B. Minster
8:45	Universe Division Report	E. Smith
9:30	Solar System Division Report	A. Dantzler
10:1	BREAK	
10:30	Earth-Sun System Division Report	M. Cleave
11:15	General Discussion	A. Christensen B. Minster
12:00	LUNCH with Science Talk: "Early Results from Cassini	L. Spilker/JPL

1:00	***Break-out Session (ends at 4:30)***	
	Earth Science Research Strategy	***ESSAAC***
1:00	SEUS Report and Action Requests	R. Kolb
1:45	OS Report and Action Requests	D. Spergel
2:30	SECAS Report and Action Requests	M. Thomsen
3:15	BREAK	
3:30	SSES Report and Action Requests	J. Lunine
4:00	Special Report on Mars Topics	J. Lunine
4:15	Special Report on Moon Topics	J. Lunine
4:30	Plenary Session: General Discussion	A. Christensen B. Minster
5:30	ADJOURN	

November 17, 2004

8:30	Letter Development	A. Christensen B. Minster
10:00	Report to the AA and Discussion	A. Christensen B. Minster
11:00	ADJOURN	

SPACE SCIENCE ADVISORY COMMITTEE (SScAC)
MEMBERSHIP LIST
November, 2004

Dr. Andrew B. Christensen, Chair
Northrop Grumman Space Technology

Dr. David W. Deamer
University of California, Santa Cruz

Dr. Stephen A. Fuselier
Lockheed Martin Advanced Technology Center

Dr. Jonathan E. Grindlay
Harvard-Smithsonian Center for Astrophysics

Dr. Heidi B. Hammel
Space Science Institute

Dr. Fiona A. Harrison
California Institute of Technology

Dr. Garth D. Illingworth
University of California, Santa Cruz

Dr. Judith T. Karpen
Naval Research Laboratory

Dr. Andrew C. Klein
Oregon State University

Dr. Edward W. Kolb
Fermi National Accelerator Laboratory

Mr. Martin P. Kress
Battelle Memorial Institute

Dr. Jonathan I. Lunine
The University of Arizona

Dr. Jeremy R. Mould
National Optical Astronomy Observatory

Dr. John F. Mustard
Brown University

Dr. David N. Spergel
Princeton University

Dr. James Stith
American Institute of Physics

Dr. Michelle F. Thomsen
Los Alamos National Laboratory

Dr. Michael W. Werner
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SPACE SCIENCE ADVISORY COMMITTEE
November 15–17, 2004
Marriott Newport Beach
Irvine, California

MEETING ATTENDEES

SScAC Members:

Christensen, Andrew, *Chair*	Northrop Grumman Space Technology
Allen, Marc, *Executive Secretary*	NASA Headquarters
Fuselier, Stephen	Lockheed Martin
Grindlay, Jonathan	Harvard-Smithsonian Center for Astrophysics
Hammel, Heidi	Space Science Institute
Harrison, Fiona	California Institute of Technology
Illingworth, Garth	University of California Santa Cruz
Karpen, Judith	Naval Research Laboratory
Kolb, Edward "Rocky"	Fermi National Accelerator Laboratory
Kress, Martin	Battelle Memorial Institute
Lunine, Jonathan	University of Arizona
Mould, Jeremy	National Optical Astronomy Observatory
Mustard, John	Brown University
Spergel, David	Princeton University
Stith, James	American Institute of Physics
Thomsen, Michelle	Los Alamos National Laboratory
Werner, Michael	NASA/JPL

ESSAAC Members:

Smarr, Larry, Chair	California Institute of Telecommunications and Information Technology
Crawford, Melba	Center for Space Research
Denning, Scott	Colorado State University
Jacob, Daniel	Harvard University
Jezek, Kenneth	Ohio State University
Johnson, Roberta	University Corporation for Atmospheric Research
Killeen, Timothy	National Center for Atmospheric Research
Minster, Jean-Bernard	Scripps Institution of Oceanography
Trumbore, Susan	University of California, Irvine
Ulaby, Fawwaz	University of Michigan
Williams, Gregory, *Executive Secretary*	NASA Headquarters
Yoder, James	National Science Foundation

NASA Attendees:

Asrar, Ghassem	NASA Headquarters
Beichman, Charles	NASA/JPL
Cleave, Mary	NASA Headquarters
Crawford, James	NASA/LaRC
Dantzler, Andrew	NASA Headquarters
Devirian, Michael	NASA/JPL
Diaz, A.V.	NASA Headquarters
Emanuel, William	NASA Headquarters
Feeley, T. Jens	NASA Headquarters
Fisher, Richard	NASA Headquarters
Friedl, Randall	NASA/JPL
Green, Ken	NASA/JPL
Kaye, Jack	NASA
McNally, Alison	NASA Headquarters
Mace, Thomas	NASA/DFRC
Nelson, Robert M.	NASA/JPL
New, Michael	NASA Headquarters
Norris, Marian	NASA Headquarters
Smith, Eric	NASA Headquarters
Thronson, Harley	NASA Headquarters
Varsi, Giulio	NASA/Headquarters
Walton, Amy	NASA Headquarters
Wiseman, Jennifer	NASA Headquarters

Other Attendees:

Beckwith, Steve	AURA/Space Telescope Science Institute
Freedman, Wendy	Carnegie Observatories
Kapplin, John	General Dynamics–Spectrum Astro
Katt, Robert	INFONETIC
Malay, Jon	Lockheed Martin
Margon, Bruce	Space Telescope Science Institute
Purdy, William	Ball Aerospace
Roberts, Mel	Spectrum Astro/General Dynamics
Smith, David B.	Boeing
Wilson, Gary	BATC

SPACE SCIENCE ADVISORY COMMITTEE
November 15–17, 2004
Marriott Newport Beach
Irvine, California

LIST OF PRESENTATION MATERIAL[1]

1) A.V. Diaz, Associate Administrator, NASA Science Mission Directorate, *Earth/Space Science Advisory Groups*. November 15, 2004.
2) Paul Hertz, Assistant Assoc. Administrator for Science, NASA Science Mission Directorate, *Science Management Process in the Science Mission Directorate*. November 2004.
3) *Discussion on Process*
4) Marc S. Allen, Lead, Strategic Roadmap Development, NASA. *NASA Strategic Roadmapping: Briefing to the Space Science Advisory Committee and Earth System Science and Applications Advisory Committee.* November 15, 2004.
5) Marc S. Allen, Science Mission Directorate. SMD Advisory Committee Reorganization Overview. 15 November 2004.
6) Eric P. Smith (for Anne L. Kinney, Director, Universe Division). *Universe Division Overview Presented to Earth/Space Advisory Committees.* November 17, 2004.
7) Andrew Dantzler, Acting Director, Solar System Division. *Solar System Exploration.* November 2004.
8) Mary Cleave, Acting Director, Earth-Sun System Division. *Earth-Sun System Division. Science Overview.*
9) William Emanuel, Program Scientist, Terrestrial Ecology, Earth-Sun System Division. *Science Mission Directorate. Earth Science Research Planning.*
10)
11) Edward "Rocky" Kolb, Chair, SEUS. *Structure and Evolution of the Universe. Beyond Einstein: From the Big Bang to Black Holes. SEUS Report to the SScAC*. November 2004.
12) David Spergel, Chair, OS. *Origins Committee Report.*
13) Jonathan L. Lunine, Chair, SSES. *Solar System Exploration Subcommittee.*
14) Michelle Thomsen, Chair, SECAS. *Recent Sun-Earth Connection Advances* and *Findings from the Sun-Earth Connection Advisory Subcommittee Meeting of November 3–5, 2004.*

[1] Presentation and other materials distributed at the meeting are on file at NASA Headquarters, Science Mission Directorate, Washington, DC 20546.

Letter from the Chair, Astronomical Search for Origins Subcommittee, to the Chair, Space Science Advisory Committee

Dear Andy:

The Origins Subcommittee met on November 9 and 10 in College Park, Maryland. Much of the meeting was held in joint session with the Structure and Evolution of the Universe Subcommittee.

Anne Kinney briefed the joint Subcommittees on the status of the Universe program. With HST, Spitzer, Chandra and many smaller missions producing exciting science, we are in the midst of a very exciting time for astrophysics.

Marc Allen reviewed the new plans for roadmapping. As NASA restructures its plans, we are all eager to provide useful input in the most effective form.

TECHNOLOGY

We are very concerned that the disappearance of Aerospace Technology funding within NASA will further exacerbate the problem of developing mid-TRL technologies for Universe Division missions. New detectors, optics, cryocoolers, etc. are needed to implement Origins Probes, Visions Missions, and near-term balloon payloads, explorers, and future SOFIA instruments. Mel Montemerlo put together a very good plan that documents many of these needs and many of the technologies that will be essential to future astronomical missions. The Origins Subcommittee advocates that the Universe Division to outline a plan for bridging this technology funding gap and develop a strategy for long-term technology funding. **We request that this plan include new opportunities for high priority technologies in the near future (FY05) and that it be presented at the next meeting with as many details as possible.**

DSN

Barry Geldzhaler briefed the Origins Subcommittee on plans for upgrading the Deep Space Network. The next generation DSN will have significantly higher bandwidth. For many of the planned OS missions, low operations costs and dependability will be as important as high bandwidth. **We recommend that the SscAC review the plans of the DSN to assure that they are matched to the strategic needs of NASA science.**

JWST Ariane Launch

As we discussed in our previous report, the James Webb Space Telescope—the top priority in the Astronomy Decadal Survey and a vital tool in our efforts to explore the universe—continues to face a significant financial and schedule risk. As part of its contribution to the construction and launch of JWST, ESA has agreed to provide an Ariane V launch at no cost to NASA. Unfortunately, the interagency process required for this approval has not moved forward. If this launch plan is slipped or abandoned, the cost of JWST will grow significantly and NASA's relationship with ESA will be damaged at a time when (according to the President's Vision and the Aldridge Commission report) international cooperation is very important for the success of

the Space Exploration Initiative. **We recommend that the SscAC asks the Science Mission Directorate (SMD) to aggressively seek interagency approval for the Ariane launch for JWST as a near-term high priority activity.**

TPF-C

The rapid advances in the development of TPF-C have been one of the exciting developments within the Origins program. Since TPF-C is now scheduled to launch several years ahead of TPF-I, we encourage NASA to make its funding the top priority within the TPF program**. We have several specific recommendations for the TPF-C program: (1) the new STDT be a balanced committee with a significant representation of general astrophysicists; (2) the TPF project work to maximize community involvement by supporting multiple instrument options and groups, and (3) we encourage the TPF project to compete the starlight suppression system in TPF-C.**

HST

Jennifer Wiseman and Colonel M. Borkowski briefed the Origins Committee on progress on the Hubble robotic mission. The planned mission is a very ambitious program and would represent a major advance in robotics. We are concerned that the process of evaluating the costs and science return of the various HST refurbishments options and are also concerned about the impacts of these costs on other parts of the Origins program. We are eager to maximize community involvement in evaluating these trade-offs.

Balloons

Martin Israel briefed the joint Origins/SEUS on the balloon roadmap. The Balloon Roadmap team identified a high-priority need for increased capability for Long-Duration Balloon flights. The long-duration balloon flights (and future ultra-long duration balloon flights) have grown too large and complex to be accommodated in the SR&T program. At present, the only avenue is to compete as a Mission of Opportunity in the Explorer competitions. The Balloon roadmapping team advocated a special line within the Explorer program for the balloons. However, since the balloon missions have successfully competed in the current framework, the OS did not endorse allocating Explorer funds exclusively for balloons and favors continuing to compete the balloons against other Explorer missions.

Roadmapping

The OS reviewed and discussed plans for the 2005 NASA roadmap. We are confident that the SEU and Origins roadmaps can be successfully melded into a joint "Universe" roadmap. With the compressed schedule, there is a concern that there will be little time for community interaction in the roadmapping process. The roadmapping teams will need to ensure that there are well-publicized opportunities to present roadmap outlines and elicit community response (e.g., at the AAS meeting in January).

Vision Missions

The leaders of various Vision Missions briefed the joint Origins and SEU Subcommittes on the interim results of their team studies. The range and scientific potential of these novel missions was very exciting. The OS thanks the team members for their efforts, which will provide useful input for the long-range planning in the roadmap. We encourage NASA headquarters to initiate similar studies in 2008 that will provide input for the NAS decadal survey process.

This is the last report of the OS. We look forward to working more closely with our SEU colleagues as part of the new Universe Subcommittee.

We look forward to working with Anne Kinney in her new role as Director of the Universe Division and with Al Diaz in his new role as Associate Administrator for Science. We want to thank Ed Weiler for his contributions as Associate Administrator and wish him success in his role as Director of Goddard Space Flight Center.

Sincerely yours,

David Spergel, for the Origins Subcommittee

**Letter from the Chair, Sun–Earth Connection Subcommittee,
to the Chair, Space Science Advisory Committee**

International, Space, and Response Technologies Division

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November 7, 2004
ISR-1-04-137

Dr. Andrew Christensen
Northrop Grumman Space Technology
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Redondo Beach, CA 90278

Dear Andy,

The Sun-Earth Connections Subcommittee met in Washington on November 3-5. We had a very busy and productive meeting. A copy of the agenda is attached to this letter.

Since we are aware of the upcoming reorganization of the advisory committee structure, one focus of our meeting was an effort to increase our understanding of the scope and objectives of the Earth Sciences programs, with which Sun-Earth Connections is being merged. We heard presentations by Mary Cleave, Jack Kaye, Greg Williams, and Gordon Johnston that were very helpful in introducing to us the breadth of important activities going on within the Earth Sciences effort. We look forward to discovering and pursuing the opportunities for scientific interchange and collaboration that will be afforded by the new organizational structure. In a similar spirit, we also took a look at what aspects of the existing structure have been helpful to SECAS in carrying out our designated tasks. One thing we have found particularly valuable is our MOWGs, which are essentially sub-subcommittees that provide us with in-depth professional expertise and insights into more narrowly focused parts of the full SECAS purview. One of the findings described below is that a similar structure would also probably well serve the successor to SECAS.

Another important activity at our meeting was a discussion of the ongoing roadmapping process. We heard a presentation by Todd Hoeksema, the chair of our legacy roadmapping committee, on their progress and plans. We were quite pleased with the careful and comprehensive approach they are taking, and we expect the outcome to be a very positive and progressive guide to the future program. In our discussion of the overall process, however, concerns were raised about the interfaces between the various roadmapping teams; specifically, we are concerned that some research areas that do not fit neatly into the defined boxes may fall between the cracks. This concern led us to our second finding below.

We greatly appreciate the time that Al Diaz spent with us during this meeting. We had a useful and positive interchange of thoughts. In our discussion, he asked us to give him ideas on how we might contribute to making the new structure work effectively, especially in pursuit of the Exploration Initiative objectives. Our response is indicated in our finding number 4.

Specifically, we intend to use the roadmap process to delineate the numerous ways in which SEC science can contribute to NASA's Exploration Vision, exploiting unique capabilities that emerge from our foundation of basic scientific understanding of the workings of the Sun-Earth (indeed, Sun-Planets) system. And, because there remain many unanswered questions (some known, some as yet unknown) about this complex system and its importance for human and robotic exploration activities, we must also continue to strengthen the underlying foundation of fundamental physical understanding.

Finally, I would like to call attention to our finding #5. During the course of the meeting, we learned that there may be a way at hand to address our long-standing need for relatively inexpensive access to space, namely in the excess lift capacity of several of the launch vehicles that are already scheduled for NASA payloads. We would very much like to see this possibility explored.

Our full set of findings is attached.

This was the last SECAS meeting for several of our members, whose terms on the committee expire this month (Jeff Forbes, Jim Klimchuk, Dave Klumpar, Dana Longcope, and Bill Matthaeus). We very much appreciate the time and effort they have devoted to this important community service.

Best regards,

Michelle F. Thomsen
SECAS chair

cc Al Diaz, Mary Cleave, Richard Fisher

attachments

SECAS Findings from 3-5 November 2004 Meeting
Agenda for 3-5 November 2004 SECAS Meeting

Summary of SECAS Findings, 3-5 November 2004

1. *Advisory Committee Structure*

Issue: NASA's new Science Mission Directorate is aligning its advisory committee structure with its divisions, including the Earth-Sun System Division. In response to a question from SECAS, Mr. Diaz said that he welcomed comments from the existing committees on how the new structure might function most effectively.

Background: SECAS has been well served by discipline-specific MOWGs (Management Operations Working Groups), the chairs of which also serve on SECAS. Each MOWG provides grass-roots information and specific findings that SECAS integrates with other MOWG findings and uses to inform its own discussions and findings. The in-depth expertise of the MOWGs complements and supports the diverse membership of SECAS; such a resource is likely to be even more valuable for its broader-scope successor committee.

Recommendation: SECAS recommends that the Earth-Sun System Division retain standing working groups, similar to MOWGs, that report to the Earth-Sun System Subcommittee.

2. *Coordination of Parallel Roadmapping Activities*

Issue: There is a need to assure effective communication between Agency Strategic Roadmapping activities. There are three specific concerns: timing, smooth interfaces between roadmaps, and coordination and exploitation of interdisciplinary opportunities.

Background: Within the new Science Mission Directorate, we are now engaged in an Agency Strategic Roadmap activity. Thirteen strategic roadmap teams and sixteen capability roadmap teams are being formed, in general each responsible for an individual NASA Objective. Sun-Solar System Connection (S3C) science is defined by one of these objectives and is relevant to at least two other science roadmaps and a number of capability roadmaps.

Recommendation: So that roadmaps will be compatible, consistent, and exploit interdisciplinary opportunities, we recommend that there be effective and timely communication among the roadmapping teams (both legacy and APIO), e.g., via designated liaisons between roadmapping activities.

3. *Constitution of the Sun-Solar System Roadmap Team*

Issue: There is presently a disciplinary imbalance within the membership of the legacy SSSC roadmap committee that presents a gap in expertise in addressing some aspects of Sun-Solar System physics.

Background: A discipline-balanced team had initially been selected. However one member with heliospheric research expertise had to step down, leaving the important area of heliospheric physics with inadequate representation in the planning process.

Recommendation: We recommend that one or two additional members from the heliospheric community be appointed to the legacy roadmap team to ensure that there is appropriate coverage of this area.

4. *Supporting the Exploration Initiative on A Foundation of Basic Understanding*

Issue: There is a strong imperative to maintain progress in basic understanding of the connected Sun-Earth system to enable support of the Exploration initiative and future initiatives.

Background: Associate Administrator Al Diaz briefed SECAS on the new Earth-Sun System Division, outlining the Administration's commitment to continuing SEC's strong space science research program, and emphasizing the potential for our discipline to contribute to the scientific basis for Exploration, as well as the potential for Exploration activities to afford opportunities for enhancing scientific research and discovery. He encouraged SECAS to give him feedback on how SEC science can best contribute to the new vision. We were pleased to receive his enthusiastic support for the discovery nature of our research and for the SEC perspective of the fully connected Sun-Earth system. Through the present roadmapping process, we are reviewing our scientific activities to formulate a coherent strategy to engage in the Exploration Initiative. SECAS believes that our community has much to contribute: Comprehensive knowledge and understanding of solar activity, the interplanetary medium, heliospheric energetic particles, and the environments of planets and moons are required for human safety, spacecraft design, and mission planning related to human and robotic exploration of the solar system. These potential contributions clearly build upon the foundation of basic understanding that is being built through a diverse set of programs of scientific exploration: the Solar-Terrestrial Probes line, the LWS Program, the Explorer and Rocket Programs, as well as Theory, Guest Investigator, and Supporting Research and Technology Programs. Such a foundation is also the best way to ensure that this discipline will be able to support future initiatives, as yet unimagined. Therefore, the challenge to our present strategic planning effort is how to exploit and expand existing knowledge to support the Exploration Initiative, while continuing the fundamental exploration needed to build a solid foundation of basic understanding of the connected system of the Sun, Earth, and planets.

Recommendation: SECAS urges the Science Mission Directorate to be mindful of the need to maintain and strengthen a broad foundation of basic understanding in order to support effectively the Exploration vision and other future initiatives.

5. *Effective Utilization of Excess Payload Capability on NASA Launches*

Issue: Access to space is limited and costly. Small and moderate size scientific satellites are particularly difficult to manifest owing to the often-prohibitive cost of obtaining a dedicated launch vehicle. A standard adapter to accommodate secondary payloads within the EELV fairing could alleviate this inefficiency and open the door to more frequent launch opportunities for this class of satellites.

Background: The lack of ready access to space for low cost has resulted in suspension (e.g., UNEX) or the near cancellation (e.g. ST-5) of scientifically compelling missions. At the same time, scientific spacecraft being launched to Earth orbit are often smaller and lighter than the launch booster capacity, resulting in potential underutilization of precious launch capability. NASA has no standard secondary payload adapter for use on US boosters. This is in contrast to the European Ariane launcher, where every launch carries secondary payloads to utilize excess capability. We understand that the DoD Space Test Program has a secondary payload adapter for the EELV under development. However, as far as we know, NASA neither participates in this development, nor has initiated development of its own secondary payload accommodation.

Recommendation: SECAS urges NASA to take an active role in the development of a generic capability to utilize excess payload capacity on launch systems when the primary NASA payload

does not require the entire capacity, and we request a report on the feasibility of such a development for discussion at our next meeting.

6. *International Heliophysical Year*

Issue: NASA is encouraged to participate in the programs commemorating the 50th anniversary of IGY1957.

Background: Worldwide campaigns in geophysics like the International Polar Years in 1888 and 1932 and the International Geophysical Year in 1957 have left a rich legacy of new science discoveries and expanded geophysical measurement capabilities founded on international cooperation. They play a very important role in the development of space science as a discipline and in public recognition of our accomplishments. On the 50th anniversary of the last IGY, several new worldwide campaigns are being planned – the International Polar Year (IPY) 2007, the International Heliophysical Year (IHY) 2007 and the Electronic Geophysics Year (eGY) 2007. As in past campaigns, these efforts hold the potential for driving new and innovative ways of viewing and modeling the Sun, heliosphere, geospace and planetary systems that make use of data from multiple satellite missions and distributed sets of ground-based sensors, but place new emphasis on the role of theory, global modeling and data assimilation in producing new knowledge about the global Sun-Earth system behavior. As in previous IGYs, there is a strong emphasis on the Sun-Earth interaction but, in contrast to previous efforts, parallel investigations are envisioned in Sun-planet system research.

Recommendation: SECAS recommends that the Science Mission Directorate look into ways to help make the coming IGY programs a success.

AGENDA - SECAS – NOVEMBER 3-5, 2004
NASA HEADQUARTERS

WEDNESDAY, 3 NOVEMBER 2004: Location: HQ MIC6 (6H46)

0815	Meeting Room Open, Coffee	
0830	Welcome	Michelle Thomsen
0840	Earth-Sun Systems Division	Mary Cleave
0900	Sun-Solar System Connection Update	Richard Fisher
1000	Sun-Solar System Connection Mission Update	Charles Gay
1015	Break	
1030	MOWG reports (15 min each) Living with a Star Geospace Solar-Heliospheric	 Glenn Mason Jim Clemmons Steve Suess
1100	Future Advisory Committee Structure	Greg Williams
1130	Introduction to the Earth Science Program	Jack Kaye

1200	Group Lunch: Science Presentation

1300	ROSES-2005	Paul Hertz
1315	Solar Terrestrial Probes Update	Eric Christian
1345	Agency Strategic Planning and the SSSC Roadmap	Barbara Giles
1415	Break	
1430	Sun-Solar System Connections Roadmap Update	Jeff Forbes and Todd Hoeksema
1530	Solar System Exploration Roadmap Activities	Nathan Schwadron
1545	Earth Science Roadmap Activities	Gordon Johnston
1600	Roadmap Discussion	Committee
1700	Adjourn	
1830	Group Dinner	

THURSDAY, 4 NOVEMBER 2004: Location: HQ PRC (9H40)

0815	Meeting Room Open, Coffee	
0830	International Heliophysical Year/Electronic Geophysical Year	Joe Davila
0900	Sounding Rocket Program Review	Gerry Daelemans
0930	Living with a Star Update	Lika Guhathakurta
1000	Break	
1015	Project Columbia	Tsengdar Lee
1045	Magnetosphere Constellation	Alex Klimas

1115	Lunch on your own – e.g., cafeteria or grill on 1st floor/café on 9th floor

	MOVE TO HQ AUDITORIUM	
1200	Science Presentation in the auditorium	George Siscoe
	RETURN TO MEETING ROOM	
1315	Discipline Scientist Roundtable	HQ Discipline Scientists
1400	Science Missions Directorate Update	Al Diaz
1500	Break	
1515	Discussion and Writing Assignments	Committee
1700	Adjourn	
1830	Group Dinner	

FRIDAY, 5 NOVEMBER 2004: Location: HQ PRC (9H40)

0815	Meeting Room Open, Coffee	
0830	Committee Writing Time	Committee
0915	Review of Findings	Committee
1030	Break	
1045	Review Findings with Fisher/Cleave	Committee/Fisher/Cleave/Division
1145	Committee roundtable	Committee
1200	Adjourn	

END OF MEETING

Letter from the Chair, Structure and Evolution of the Universe Subcommittee, to the Chair, Space Science Advisory Committee

To be added

Letter from the Chair, Solar System Exploration Subcommittee, to the Chair, Space Science Advisory Committee

TO: **Andrew Christensen, Chair, Space Science Advisory Committee**

FROM: **Jonathan I. Lunine, Chair, Solar System Exploration Subcommittee**

SUBJECT: **Solar System Exploration Subcommittee Meeting**

The Solar System Exploration Subcommittee (SSES) of the Space Science Advisory Committee (SScAC) met October 21-22, 2004 at NASA Headquarters. The purpose of this memorandum is to summarize the findings of that meeting and ask SScAC to consider them and transmit its recommendations to Mr. Andrew Dantzler, Director of the Solar System Exploration.

Administrative changes

SSES welcomes Andrew Dantzler as acting Director of the Solar System Exploration Division, and Doug McCuistion as Director of Mars Exploration. SSES is also extremely pleased that Dr. James Garvin has been named NASA Chief Scientist, indicating the importance the NASA Administrator places on exploration of the solar system. We look forward to working with all of them during these exciting and challenging times.

SSES, in recognizing the organizational transformation currently taking place within NASA, also wishes to express concern about the multitasking of high-level personnel into several duties simultaneously. SSES believes this will lead, sooner or later, to a detrimental stressing of the system, delays in programming, and burnout of personnel. SSES urges that NASA Headquarters fully staff offices at the program level to better meet the needs of the directorates and their customers.

Discovery

Discovery remains the archetypical program of PI-led missions within Solar System Exploration. The return of solar wind samples to the Earth in a crash landing of the Genesis capsule this past September 8 illustrates both the scientific promise and technical/programmatic problems associated with the Discovery Program. SSES was pleased to see the successful launch and initial operations of Messenger on the way to Mercury, as well as the continued nominal operation of Stardust and delivery to the launch site of Deep Impact. However, most of these missions, as well as Kepler now under development, have had significant cost and technical issues, and there have been outright (CONTOUR) and partial (Genesis) technical failures.

SSES is pleased to see that NASA continues to take steps to control cost and reduce risk in the Discovery Program. In particular, the staffing and activation of the new Discovery/New Frontiers Program office at Marshall Space Flight Center is an important step in creating a strong agency managerial presence in this program. We look forward to a dialog with the Program Manager, Todd May, to brief him on our previous Discovery Program findings and discuss his plans for the Program Office.

SSES congratulates NASA on moving forward quickly with selection processes for Discovery missions 11 and 12. We recognize that the timing of the selection process for the following Discovery mission, number 13, may be contingent on the nature of the selections for 11 and 12,

as well as budgetary issues with missions currently under development. SSES will revisit these issues in early-to-mid 2005 to assess the ability of the program to control cost and risk, and to maintain the frequent launch rate that is an essential characteristic of the program.

JIMO

The Jupiter Icy Moons Orbiter (JIMO) currently represents the sole focus of NASA Outer Solar System Exploration beyond the Cassini and New Horizons missions. Under the most recent development schedule, the 2021-2022 arrival in the Jupiter system entails a lengthy delay in addressing scientific questions of high scientific priority, most notably the astrobiological potential of Europa.

SSES is increasingly concerned that the JIMO mission design, and the underlying Prometheus power system development, pose a number of very significant technical challenges. At present, the required funding profile to accomplish a JIMO launch by even 2015 with adequate reserves is poorly understood. SSES encourages the most rapid possible determination of the JIMO cost profile, and its endorsement by NASA and the Congress. SSES plans to examine the status of the JIMO mission at its summer 2005 meeting, after the DOE Office of Naval Reactors presents its reactor feasibility study and Northrup Grumman Space Technologies presents its Phase A design.

SSES strongly urges NASA to develop a robust planning effort for the scientific exploration of the outer planets, as a guide to mission design efforts that might utilize Prometheus technologies and more conventional approaches. This will provide a programmatic strategy for outer solar system exploration with the flexibility to implement missions that address high-priority science issues.

Mars

The exploration of Mars has achieved a remarkable and unprecedented level of success over the past year. There are five functioning spacecraft at Mars --Mars Global Surveyor, Odyssey, and ESA's Mars Express in orbit, and the MER Opportunity and Spirit rovers on the surface. The two rovers, Opportunity in particular, have discovered unambiguous evidence that Mars was once wet, with large standing bodies of water, and have far exceeded their designed performance in terms of distance traveled and terrains covered. As was hoped, the MER missions have focused Mars exploration from four original pathways to three over the coming decade, which increases the priority of Mars sample return in 2013. SSES urges the Mars Exploration Program (MEP) Office to move aggressively on advanced planning activities to support missions beyond the 2009 timeframe.

We note that the Mars Exploration Program is one of the crown jewels of NASA. As robotic activities leading to the human exploration of Mars ramp up, we urge NASA not to lose focus on the science goals for Mars exploration. Science missions and human precursor missions should take full advantage of possible synergies between the exploration and science programs.

SSES is pleased by the increasing engagement of the astrobiological community in Mars mission planning and activities, and urges NASA to strongly encourage the involvement of the next generation of astrobiologists in mission planning, development and execution.

Lunar Reconnaissance Orbiter

Although the goals of the Lunar Reconnaissance Orbiter (LRO) are primarily exploration-driven, the SSES recognizes that these goals are also quite relevant to highpriority lunar science. This is especially true of the important issue of the existence and nature of lunar polar volatiles. Therefore, the SSES concludes that the complement of instruments selected for the LRO mission will most likely contribute substantially to lunar science goals. Many important lunar science goals described in the NRC's Solar System Decadal Survey are not explicitly addressed by LRO, and should be addressed by future lunar missions.

Overall, the SSES is pleased with the linkage between the Exploration and Science Mission Directorates as represented by the LRO mission. It is laudable that measurement data from LRO will be archived in the PDS for use by science investigators, in addition to the exploration community. The SSES believes that the goals of future missions within the Robotic Lunar Exploration Program (RLEP) should be explicit about the important ties between lunar exploration and lunar science, as the two are inherently linked. Preserving these ties is vital to the long-term success of LRO and the RLEP.

Planetary Data System

The Planetary Data System (PDS) was established to provide the planetary science community with access to high quality, peer-reviewed datasets, which include calibrations, documentation and other ancillary information. The PDS has experienced difficulties with late deliveries of data products and non-PDS compliant deliveries from flight projects.

SSES commends the PDS efforts to bring products up to compliance and in their efforts to ensure that PDS guidelines are provided in solar system AOs. The SSES was very pleased to see that discussions have begun with the Sample Curation Facility to coordinate archiving of ancillary information related to sample collection in response to our previous recommendations. In response to continued frustrations from the science community with the ease of use of the PDS system and community unhappiness with the management of the system, two evaluations of the PDS Central Node were conducted this past year, and various options are being considered.

SSES strongly supports the idea that the infusion of planetary science understanding in program management is necessary. This could be accomplished either with a scientist high up in the management structure, or with a scientific ombudsman who could act as a liaison between management and the scientific community. There was discussion concerning the purpose of a Central Node in an era of distributed networks, however, the SSES notes that the program office may still have technical functions to fulfill.

New Technology Program

Solar System Exploration Division seeks to develop and validate technologies for broad applicability in future missions. However, flight validation of new technologies is often hampered by the high costs required for stand-alone missions. Feeder programs in the former Code R, that supplied basic technology components, have disappeared. NASA is considering the possibility of using existing spacecraft whose primary missions have been accomplished, but which still have available resources, to help validate new technologies where appropriate (e.g., navigation software). This has been done successfully in the Mars Program, and might be extended to include Discovery and New Frontiers missions.

SSES notes two challenges to this approach. First, while technological objectives are legitimate goals of extended operations for scientific missions, these objectives need to be competed against the potential science that extended missions can return. Ideally, the technology demonstrations would enable or enhance scientific observations and data return in the extended mission. Second, in this era of cost-constrained missions, the technology demonstration requirements need to be fully understood and funded by their sponsors, including the full costs of accommodation on the spacecraft and of impacts on mission operations. Otherwise, the primary phase scientific objectives may be impacted or the technological objectives themselves may be compromised. SSES believes that these challenges can be met and encourages NASA to continue to support new technology efforts essential to accomplish its scientific and exploration goals.

Sincerely

Jonathan I. Lunine, Chair

Letter from the Chair, Space Science Advisory Committee, to the Associate Administrator, Science Mission Directorate

Space Science Advisory Committee (SScAC) Report
November 15 - 17, 2004
Newport Beach, CA.

Mr. Al Diaz
AA Science Mission Directorate
NASA
Washington D.C.

Jan 11, 2004

Dear Mr. Diaz:

It was a pleasure to meet with you and members of your staff at the Space Science Advisory Committee (SScAC) meeting held November 15 – 17, 2004 in Newport Beach, CA. It was also our delight to have members of the Earth Systems Science and Application Advisory Committee (ESSAAC) meet with us. It was a great opportunity to get acquainted in preparation for the planned merger of the two committees to form the science advisory committee for the Science Mission Directorate. I would like to thank Larry Smarr, the Chair of ESSAAC and Bernard Minster, Deputy Chair, for their leadership and contributions during the meeting.

Our meetings on the first day dealt primarily with the advisory committee issues driven by the reorganization at headquarters. Both the SScAC and the ESSAAC expressed a desire to support a successful transformation of NASA. We believe that an informed mutual understanding of concerns and issues will provide the best foundation of an effective partnership. This joint meeting was a major step forward along this road, and both committees express appreciation to NASA for being supportive in this process.

A recurring question was how to identify new opportunities created by the changes at NASA. This question was clearly the context for our discussions with Ghassem Asrar to identify areas of multidiscipline science that would benefit from the expertise and experience of both the space science and Earth science communities. And it extended to our discussions about the structure of the new advisory committee taking advantage of the different perspectives coming from our different backgrounds and approaches in the operation of the two committees. The recommendations given below reflect a consensus view of the membership of both committees.

The discussions were informed by the excellent presentations describing the division science, status and strategies by Eric Smith, substituting for Anne Kinney, Andy Dantzler, Mary Cleave, Richard Fisher and Jack Kaye. Paul Hertz joined by telephone and provided a glimpse of the management processes in SMD. Marc Allen, with his customary flair, described the NASA Strategic Roadmapping plans.

Linda Spilker, our lunchtime science speaker, visited us from the Jet Propulsion Laboratory on Tuesday. She brought us up to date on the exciting early science results from the Cassini mission. The committee really enjoys the science break and expresses their gratitude for her outstanding presentation.

Our recommendations and copies of the Subcommittee reports are appended to this letter. The committee is expecting to hear replies to our concerns expressed here at the first meeting of the NASA Science Advisory Committee (NSAC).

As this was the final meeting of the Space Sciences Advisory Committee and my final meeting as chair, I would like to thank you, the outstanding individuals on your staff, and the committee members for a truly extraordinary experience. It has been a great pleasure to share their time and to discuss important issues for the future of science. All are champions of science and it has been my good fortune to work with them. Best of life to you and success to NASA.

Sincerely

Andrew B. Christensen
Chair, Space Science Advisory Committee

Attachments:
SSES meeting report [Appendix H]
SECAS meeting report [Appendix F]
Joint OS and SEUS meeting report [Appendices E and G]

Recommendations and Findings

The Integrated SScAC and ESSAAC Advisory Structure

The committee supports the NASA plan for a combining SScAC and ESSAAC into a single Science Mission Directorate (SMD) FACA-chartered top-level committee (provisionally named the NASA Science Advisory Committee – NSAC) to advise the SMD Associate Administrator on scientific and programmatic issues. Each of the three Divisions would have a suitably constituted advisory subcommittee to advise on specific matters within each Division. The committee recognizes that a transition period will be required to evolve from the presently constituted committees to a final state with a balanced representation of members reflecting the scientific disciplines involved.

- **We recommend that the NSAC and its sub-committees be FACA chartered committees.**

- SScAC recommends that a standing working group composed of advisory committee members be formed jointly with the Exploration Systems Mission Directorate and the Science Mission Directorate to examine cross- directorate issues.

- **The SScAC recommends that three additional internal working/task groups be formed in the areas of technology, information and data systems, and Education/Public outreach. These standing working groups would be composed of members of the three NSAC subcommittees.**

- **We recommend that the current membership of SScAC and ESSAAC constitute the initial membership of NSAC and its final state arrived at though attrition and appointments as appropriate. At that time, it would be desirable to include both chairs and co-chairs of the subcommittees as members of NSAC.**

Exploration Initiative and Basic Science

Within the formal structure of the current strategic planning process and in other discussions, the NASA science community is working to help formulate a coherent strategy to engage in the Exploration Initiative. The crucial contributions that SMD can make toward enabling the Exploration Vision are themselves enabled by a firm foundation of scientific understanding that is broad-based and balanced. Further strengthening that foundation will similarly enable and perhaps stimulate future initiatives.

- **We recommend that the proposed Joint Science and Exploration Working Group document the linkage between space and Earth science activities and the overall goals of exploration.**

Balloon Program

Background: The Balloon Program has returned important scientific results. Balloon missions have contributed to spacecraft missions through instrument development. Balloon missions also have the potential to contribute in essential ways to NASA Strategic Objectives. Finally, balloons have provided a platform for training many of the leaders in Space Science. Recently the

Universe Division of the Science Mission Directorate charted a Scientific Ballooning Roadmap Team. The SEUS and OS subcommittees heard their preliminary report at the November 2005 meeting.

The Balloon Roadmap team identified a high-priority need for increased capability for Long-Duration Balloon flights. The long-duration balloon flights (and future ultra-long duration balloon flights) have grown too large and complex to be accommodated in the SR&T program. At present, the only avenue is to compete as a Mission of Opportunity in SMEX and MIDEX competitions. While balloon missions have successfully competed in such a framework, it is not clear to SScAC that this is the optimal mechanism.

- **SScAC recommends that NASA study options for expanding opportunities in the Explorer program that could be inclusive of sub-orbital missions (balloons and sounding rockets) and other Missions of Opportunity. The study, which would be reported to NSAC, would consider**

    1. The delay cost to the Explorer program.
    2. Where is the appropriate place for Missions of Opportunity. Should they be removed from SMEX and MIDEX competitions and only included in a UNEX competition?
    3. Within the fixed budget of the Explorer program, which strategy would maximize the science return per dollar.
    4. The possible impact on the sub-orbital program base of an Explorer option.
    5. Other options for enabling support of UNEX class missions to make use of pending enhanced sub-orbital capabilities (e.g. ULDB, as recommended in a Decadal Survey).

Education and Public Outreach (E/PO)

Background: The Education and Public Outreach (E/PO) effort of NASA Space Science has arguably been one of NASA's most successful efforts to engage the public and to inspire the next generation of explorers. The program has been a model demonstrating how to effectively integrate education and public outreach with the space science community's activities. The effectiveness of the program is, in no small measure, the result of strong leadership within the office of the Associate Administrator (AA) and of direct and sustained involvement of scientists in E/PO. Scientists are uniquely capable of communicating NASA discoveries and research, and their expertise provides scientific integrity, models of discovery, inquiry, and critical thinking – essential attributes of life-long learning. Scientist involvement is the most direct and robust means of sharing the discoveries of NASA and involving the public.

The science community is motivated to participate in the E/PO program by the sense of ownership engendered by mandating E/PO as a key component of all missions and research programs. Thus, keeping scientists intimately and personally involved in the E/PO activities is critically important.

The former Space Science Education Officer (EO) successfully fostered a willingness on the part of practicing scientists to integrate education and public outreach into their science missions. His success was due to strong support by the AA, the EO's firm foundation as a scientist and his recognition by practicing educators as knowledgeable about and supportive of pedagogical issues. Another equally critical element of his success was involving partners that specialized in this area, so that their experience, networks, and leverage could be accessed for effective E/PO programs. In short, the EO had credibility in both camps and was able to build bridges that connected the two.

In the organization as presented to us, the Education Officer for the Science Mission Directorate would report to both the Chief Education Officer and the SMD Associate Administrator, but will not be part of the SMD. Within this organizational framework it is crucial that the Education Officer work with and represent the Earth and Space Science community in EPO and provide leadership, ensuring the continuity of the effective E/PO programs underway within the SMD. It is crucial that the Education Officer continue to have the strong visible support of the SMD AA. SScAC appreciates the AA's efforts to date to sustain an outstanding EPO program.

- **SScAC recommends that the Associate Administrator play a significant role in selecting and supervising the new Education Officer. We believe the Education Officer should have a strong science background and a demonstrable ability to work with the Earth and space science communities.**

Hubble Space Telescope

The Committee was pleased to receive an overview of the activities underway related to the Hubble Space Telescope. Plans for its future of this incredible scientific instrument are of great interest to the NSAC, the NASA science community, and the nation at large. The Committee was especially pleased to hear that a science trade study shall be initiated after a Preliminary Design Review of a robotic serving mission has been completed.

- **SScAC recommends that preparations begin immediately to task appropriate National Academy committees (CAA and SSB) to undertake studies that assess the scientific impact of various servicing scenarios and encompass a full range of scientific options. We also request a more thorough status report at the next Committee meeting including the proposed schedule for the science review, estimated costs and allocation of costs.**

Strategic Planning

We were encouraged to hear that the Strategic Roadmap objectives are being coupled with NASA's highest level goals and objectives, and are pleased that there is continuing effort to have these goals and objectives encompass the fundamental scientific questions in the earth and space science program. We were also pleased that efforts are being made to retain the so-called "Legacy" content by including participating scientists as co-chairs of the roadmapping committees.

- **SScAC requests that the Strategic Planning teams present preliminary reports for review by NSAC at its March meeting.**

James Webb Space Telescope (JWST)

As we discussed in our September 2004 letter to you, the James Webb Space Telescope—the top priority in the Astronomy Decadal Survey and a vital tool in our efforts to explore the universe—continues to face a significant financial and schedule risk. As part of its contribution to the construction and launch of JWST, ESA has agreed to provide an Ariane V launch at no cost to

NASA. Unfortunately, the interagency process required for this approval has not moved forward. The Project Office has told us that schedule impacts could be felt as soon as January 2005. If this launch plan is delayed or abandoned, the cost of JWST will grow significantly. Moreover NASA's relationship with ESA could be damaged at a time when (according to the President's Vision and the Aldridge Commission report) international cooperation is very important for the success of the Space Exploration Initiative.

- **SScAC recommends that the Science Mission Directorate (SMD) aggressively seek interagency approval for the Ariane launch for JWST as a near-term high priority activity.**

Technology

The Space Science Advisory Committee has repeatedly advised the NAC and NASA on the importance of advanced technology developments to enable future space science missions and to enhance their science return. Highly successful, currently operating missions such as the Spitzer Space Telescope, the Chandra X-Ray Observatory, Mars Rovers and many prior missions were enabled by many years of technology investments in detectors, cryogenics, optics, and etc. The effective reduction of > $100 million per year in the Science Mission Directorate advanced technology portfolio, occasioned by the transfer of budget authority in the reorganization of NASA, represents a significant deviation from this prudent investment and technology strategy that will surely adversely impact the advancement of space science in the years ahead.

- **SScAC strongly recommends that a robust technology program be established and funded in the SMD to meet the needs of future science missions (space and Earth science). The initial directions of this on-going technology program should reflect the priorities established in the current strategic planning/capabilities assessment process.**

- **SScAC requests that the NSAC be briefed on how SMD intends to make the required low-to-mid TRL technology investments for both the Earth and space science.**

Prometheus/JIMO

The SScAC is very concerned that the Prometheus Program may not support the JIMO mission requirements in favor of an as-yet-unspecified "technology demonstration" mission. The Jupiter Icy Moons Orbiter (JIMO) currently represents the sole focus of NASA Outer Solar System Exploration beyond the Cassini and New Horizons missions. JIMO represents a tremendous increase in capability for exploring the outer solar system, in terms of mobility, instrument power available, and high-speed data downlink to Earth. It will not only revolutionize our understanding of the Galilean satellites of Jupiter, and notably the high-value astrobiology target Europa, but it will also demonstrate capability for expanding the exploration of the outer solar system.

However, under the most recent development schedule, the projected 2021-2022 arrival in the Jupiter system entails a lengthy delay in addressing questions of high scientific priority, and further delay will push Europa exploration beyond the horizon of the NAS decadal survey that gave highest priority to that target for major (non-Mars) missions.

SScAC is increasingly concerned that the JIMO mission design, and the underlying Prometheus power system development, pose a number of very significant technical challenges. The required funding profile to accomplish a JIMO launch by even 2015 with adequate reserves is not defined.

- **SScAC recommends that NASA commit to JIMO as the first Project Prometheus mission.**

- **SScAC recommends that NASA give high priority to a full understanding of both the cost profile required to implement JIMO by 2015, and the technological challenges that must be overcome.**

- **SScAC requests a report of the status of JIMO within Project Prometheus at its next meeting.**

Terrestrial Planet Finder

At our July meeting, the Origins Subcommittee reported on NASA's decision to pursue two separate, sequential Terrestrial Planet Finder (TPF) missions: TPF-C (a coronagraph) and TPF-I (an interferometer). This is potentially an important advance for TPF, and represents a major milestone, as well as a significant change in scope of the mission. It is likely that each of these missions will be comparable to or larger than JWST in cost. This is a major step forward for one of our key astrophysical missions which may have an impact on other parts of the science program.

- **SScAC requests a briefing from the project at its next meeting so as to better understand the technical advances and other factors that led to the decision, as well as the scope and requirements for the two missions.**